CONSTRUCTION, GEOLOGIC, AND GROUND-WATER DATA FOR OBSERVATION WELLS NEAR THE SHELBY COUNTY LANDFILL, MEMPHIS, TENNESSEE

USGS
science for a changing world

U.S. GEOLOGICAL SURVEY
Open-File Report 88-486

Prepared in cooperation with the
SHELBY COUNTY DEPARTMENT OF PUBLIC WORKS

and the

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT,
DIVISION OF SOLID WASTE MANAGEMENT

Click here to return to USGS Publications

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
1988	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Construction, Geologic, and Ground-Water Data for Observation Wells Near the Shelby County Landfill, Memphis, Tennessee	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **U.S. Department of the Interior 1849 C Street, NW Washington, DC 20240**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**38**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

CONSTRUCTION, GEOLOGIC, AND GROUND-WATER DATA FOR OBSERVATION WELLS NEAR THE SHELBY COUNTY LANDFILL, MEMPHIS, TENNESSEE

By Michael W. Bradley

U.S. GEOLOGICAL SURVEY
Open-File Report 88-486

Prepared in cooperation with the

SHELBY COUNTY DEPARTMENT OF PUBLIC WORKS

and the

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT,
DIVISION OF SOLID WASTE MANAGEMENT

Nashville, Tennessee
1988

DEPARTMENT OF INTERIOR
DONALD PAUL HODEL, Secretary
U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

For additional information write to:

District Chief
U.S. Geological Survey, WRD
A-413 Federal Building
Nashville, Tennessee 37203

Copies of this report can be purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center, Building 810
Box 25425
Denver, Colorado 80225

CONTENTS

ILLUSTRATIONS

TABLES

FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM OF UNITS (SI)

For the convenience of readers who may want to use metric units rather than inch-pound units, the data may be converted by using the following factors:

Multiply inch-pound units	*By*	*To obtain metric units*
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
gallons per minute (gal/min)	0.06309	liters per second (L/s)

Sea Level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929."

CONSTRUCTION, GEOLOGIC, AND GROUND-WATER DATA FOR OBSERVATION WELLS NEAR THE SHELBY COUNTY LANDFILL, MEMPHIS, TENNESSEE

by Michael W. Bradley

ABSTRACT

Forty-one observation wells and two stratigraphic test holes were drilled near the Shelby County landfill in east Memphis. These wells were installed as part of an investigation on possible vertical leakage of ground water from the shallow aquifer into the Memphis Sand aquifer. The shallow aquifer consists of about 45 to 55 feet of alluvial silt, sand, and gravel. This is separated from the underlying Memphis Sand aquifer by about 30 to 60 feet of silt, silty sand, and clay in the confining layer.

Thirty wells completed in the alluvium were generally less than 50 feet deep. The depth to the water table ranged from about 15 to more than 45 feet below land surface. Four observation wells were completed in the upper part of the Memphis Sand at two sites. Water levels in the Memphis Sand were generally 35 to 40 feet below land surface.

INTRODUCTION

The Shelby County landfill, operated by the Shelby County Department of Public Works, receives domestic and municipal waste. Proposed expansions of the landfill led to the investigation of an area to the west of the current landfill in 1978 (Garman, Tennessee Department of Public Health, written commun., 1978) and north of Walnut Grove Road in early 1986 (Ashner, Tennessee Department of Health and Environment, written commun., 1986) by the Tennessee Division of Solid Waste Management. Data from the investigations indicated an area of depressed water levels in the shallow aquifer that could have been caused by vertical leakage to the underlying Memphis Sand aquifer.

The U.S. Geological Survey (USGS), in cooperation with the Shelby County Department of Public Works and the Tennessee Department

of Health and Environment, Division of Solid Waste Management, began an investigation of the landfill area in July 1986 to investigate the extent and amount of vertical leakage. The purpose of this report is to present data concerning well construction, lithology, and ground-water levels near the Shelby County landfill.

SITE DESCRIPTION

The Shelby County landfill is located on the east side of Memphis and has been constructed on the flood plain of the Wolf River (fig. 1). Agricultural land surrounds the landfill to the north and east, and the Wolf River forms the western and southern boundaries. The landfill area is drained by a number of intermittent streams that flow to the Wolf River. The top of the landfill is at an elevation of 290 feet above sea level, about 40 to 45 feet higher than the surrounding land surface.

The area around the landfill is underlain by unconsolidated sand, silt, and clay. The general stratigraphic sequence of concern in this area includes, in descending order, the Wolf River alluvial deposits, the Jackson Formation-upper Claiborne Group confining unit, and the Memphis Sand of the Claiborne Group (Graham and Parks, 1986).

WELL CONSTRUCTION

During July and August 1986, 30 observation wells were installed in the landfill area. Thirteen additional wells were constructed during November 1986 and June 1987 (fig. 1). Thirty-two wells were completed in the alluvial aquifer. Four of the shallow wells were later destroyed. Four wells were completed in the upper part of the Memphis Sand. These four wells are MS-1, MS-2, MS-3, and MS-4. Five observation wells (11, 24, C-1, C-2, and C-3) were completed in the confining layer. Multiple wells were installed at two sites. The first is located southwest of the landfill, near the Wolf River. The other site is located in a field north of the landfill (fig. 1). Two stratigraphic test holes, SH:Q-124 and SH:Q-130, were also drilled.

Most of the wells were drilled with a CME-55 auger rig by USGS personnel. The wells were constructed in June 1987 and the two test holes were drilled by the U.S. Army Corps of Engineers using a Failing 1500 mud-rotary drill rig. All of the wells were completed with polyvinylchloride (PVC) casing and screen and were sealed with bentonite pellets and cement slurry. Well-construction data are summarized in table 1, and construction diagrams are included in Appendix A.

All wells completed in the alluvial aquifer and underlying silt and clay of the confining unit were completed with either 2- or 4-inch screen and casing. The formation was allowed to collapse around the screen and a bentonite seal was installed to prevent the movement of water along the borehole. The remaining annulas was backfilled and a well protector and surface seal were installed. Wells drilled with the mud-rotary rig were flushed with water from the drill rig to remove the drilling mud from the borehole. Wells MS-1 and MS-2 were developed for about 8 hours using compressed air.

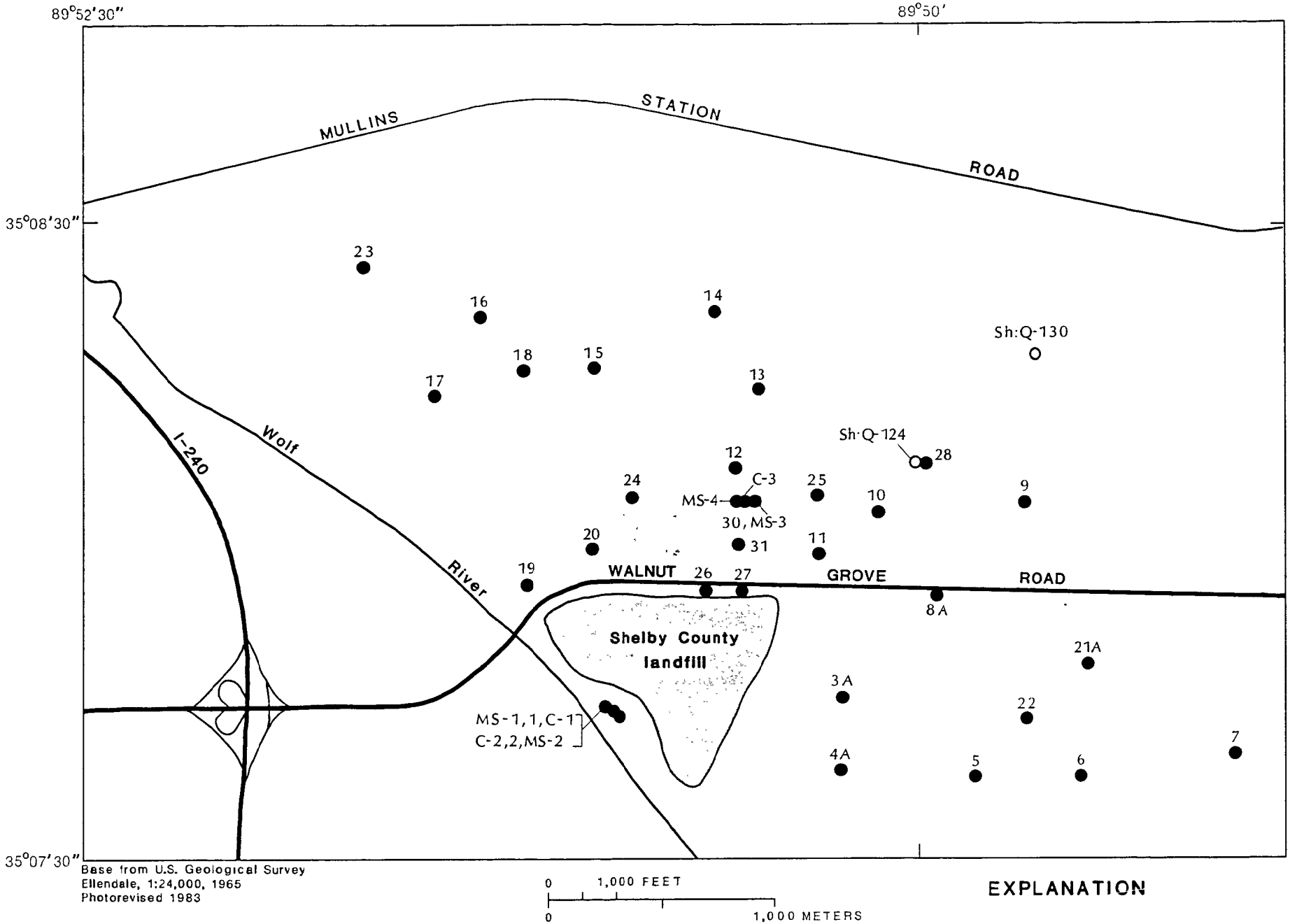


Figure 1.--Location of observation wells in the area of the Shelby County landfill.

Table 1.--*Construction data for observation wells near the Shelby County landfill*

[Method Constructed: A - Auger, M - Mud rotary]

Well number				Land elevation surface (feet)	Formation	Screened interval (feet below land surface)	Screen diameter (inches)	Date well constructed	Method constructed
Local	Project	Latitude	Longitude						
SH:Q- 95	1	350749	0895058	247	Alluvium	30.8 - 35.8	2	08-11-86	A
SH:Q- 96	2	350749	0895058	247	Alluvium	43.3 - 48.3	2	08-12-86	A
SH:Q- 97	3A	350750	0895017	253	Alluvium	45 - 50	2	08-16-86	A
SH:Q- 98	4A	350739	0895017	254	Alluvium	47.5 - 52.5	2	08-16-86	A
SH:Q- 99	5	350737	0894955	251	Alluvium	28.4 - 33.4	2	07-29-86	A
SH:Q-100	6	350732	0894930	254	Alluvium	29 - 34	2	07-28-86	A
SH:Q-10	7	350741	0894909	258	Alluvium	32.7 - 37.7	4	07-30-86	A
SH:Q-102	8A	350803	0894959	262	Alluvium	48.7 - 53.7	2	08-15-86	A
SH:Q-103	9	350814	0894943	275	Alluvium	39.3 - 44.3	2	07-28-86	A
SH:Q-104	10	350816	0895009	267	Alluvium	39 - 44	2	07-28-86	A
SH:Q-105	12	350822	0895040	252	Alluvium	38.7 - 43.7	2	04-27-87	A
SH:Q-106	13	350833	0895030	264	Alluvium	38.8 - 43.8	2	07-26-86	A
SH:Q-107	14	350844	0895032	264	Alluvium	39.5 - 44.5	2	07-26-86	A
SH:Q-108	15	350836	0895032	260	Alluvium	38.3 - 43.8	2	07-25-86	A
SH:Q-109	16	350845	0895121	257	Alluvium	39.7 - 44.7	2	07-25-86	A
SH:Q-110	17	350833	0895121	255	Alluvium	39.2 - 44.2	2	07-25-86	A
SH:Q-111	18	350838	0895113	259	Alluvium	38.3 - 43.3	2	07-25-86	A
SH:Q-112	19	350807	0895111	247	Alluvium	39.4 - 44.4	2	07-26-86	A
SH:Q-113	20	350812	0895059	248	Alluvium	38.2 - 43.2	2	07-26-86	A
SH:Q-114	21A	350753	0894933	260	Alluvium	40 - 45	2	08-16-86	A
SH:Q-115	22	350745	0894945	255	Alluvium	49.2 - 54.2	2	08-15-86	A
SH:Q-116	23	350853	0895140	246	Alluvium	23.3 - 28.3	2	11-10-86	A
SH:Q-117	24	350817	0895053	250	Alluvium	37.7 - 42.7	2	11-10-86	A
SH:Q-119	26	350804	0895041	260	Alluvium	60.1 - 65.1	2	11-12-86	A
SH:Q-120	27	350804	0895035	262	Alluvium	60.2 - 65.2	2	11-12-86	A
SH:Q-121	28	350822	0895003	273	Alluvium	22.5 - 27.5	2	11-14-86	A
SH:Q-128	30	350817	0895035	250	Alluvium	33.7 - 38.7	2	06-03-87	M
SH:Q-129	31	350810	0895035	249	Alluvium	34 - 39	2	06-08-87	M
SH:Q- 91	11	350808	0895021	262	Confining Unit	83.7 - 88.7	4	07-30-86	A
SH:Q-118	25	350717	0895019	262	Confining Unit	74 - 79	2	11-10-86	A
SH:Q-122	C-1	350749	0895058	247	Confining Unit	103 -108	2	08-12-86	A
SH:Q-123	C-2	350749	0895058	247	Confining Unit	78.5 - 83.5	2	08-12-86	A
SH:Q-127	C-3	350817	0895035	250	Confining Unit	53.3 - 55.3	2	06-17-87	M
SH:Q- 90	MS-1	350749	0895058	247	Memphis Sand	140 -170	4	07-31-86	M
SH:Q- 92	MS-2	350749	0895058	247	Memphis Sand	150 -180	6	08-15-86	M
SH:Q-125	MS-3	350817	0895035	250	Memphis Sand	80 -100	4	06-04-87	M
SH:Q-126	MS-4	350817	0895035	250	Memphis Sand	68.7 - 97.7	6	06-16-87	M

Wells 3, 4, 8, 9, 10, 11, 13, 21, and 25 were completed in the alluvial aquifer and were later found to be dry. Wells 11 and 25 were deepened and completed in the confining unit below the alluvial aquifer. Wells 3A, 4A, 8A, and 21A were installed to about 50 to 55 feet below land surface near the dry wells. The screens were filled with bentonite pellets and the casing was then grouted to land surface. Gamma and lithologic logs indicated that wells 9, 10, and 13 were completed near the base of the alluvial aquifer and that deeper wells at these sites would not provide reliable water-level data for the alluvial aquifer.

The four wells in the Memphis Sand aquifer were drilled by the mud-rotary method and completed with PVC casing and screen. Wells MS-1 and MS-2 were constructed with 30 feet of PVC screen. The formation was allowed to collapse around the screens. These wells were grouted from about the middle of the confining unit to land surface. Gravel and sand packs were placed in wells MS-3 and MS-4 and then grouted to land surface. The wells were developed by flushing the casing using the drill rig and later by surging with air.

LITHOLOGY

During well construction, geologist's logs describing the lithology at approximately 5-foot intervals and drilling conditions were recorded. Samples were collected from the auger flights, the drilling mud, and selected intervals were sampled with a split-spoon sampler. Natural gamma geophysical logs were run on all wells. Lithologic and select gamma logs are presented in Appendix A.

The stratigraphy encountered during drilling near the Shelby County landfill can be briefly summarized as: near-surface clay and silt, alluvial sand and gravel, silt, silty-sand and clay of the confining unit, and sand in the upper Memphis Sand.

The shallow clay consists of about 10 to 15 feet of top soil and brown silty clay changing to gray-brown clay near the top of the alluvial sands. These are fine- to coarse-grained sand with occasional layers of gravel. The alluvial deposits are generally 45 to 55 feet thick at this site. The confining unit underlies the alluvial deposits.

The confining unit is approximately 30 to 60 feet thick and consists of silt, silty-sand, and clay. However, the lithology and thickness of this unit may change rapidly as evidenced by gamma logs for wells MS-1 and MS-2. A clay layer encountered at 61 and 69 feet below land surface at MS-2 pinched out and is not present at well MS-1, only 50 feet away.

Wells MS-1, MS-2, MS-3 and MS-4, and the two stratigraphic test holes SH:Q-124 and SH:Q-130 were drilled into the upper part of the Memphis Sand. The upper Memphis Sand in this area consists primarily of fine- to medium-grained, gray to light gray sand. Some layers of silt and silty sand were encountered. Gamma logs for all of the Memphis Sand wells are included in Appendix A.

GROUND-WATER LEVELS

Ground-water levels were measured periodically at the observation wells (table 2). Water

levels in the alluvial aquifer generally ranged from 15 to 45 feet below land surface. Water levels at well 6 were near land surface, but the well is believed to be plugged. The shallowest water levels in the alluvial aquifer occurred at wells 1 and 2, and the deepest at wells 26 and 27. Ground-water levels in the Memphis Sand aquifer were generally 30 to 40 feet below land surface. The water level in the Memphis Sand aquifer is lower than the water table in the alluvial aquifer. Continuous water-level recorders were installed on wells MS-1, 7, and 22. Hydrographs for these wells are shown in figures 2, 3, and 4, respectively.

Table 2.--*Water-level data for wells near the Shelby County landfill*

Well number		Land surface elevation	Water level, feet below land surface			
Local	Field	(feet)	08-02-86	08-25-86	11-4-86	06-10-87
SH:Q- 95	1	247	--	15.04	--	16.36
SH:Q- 96	2	247	--	15.31	--	16.41
SH:Q- 97	3A	253	--	34.78	35.79	34.08
	3	253	dry	dry	dry	well destroyed
SH:Q- 98	4A	254	--	34.27	35.25	--
	4	254	dry	dry	dry	well destroyed
SH:Q- 99	5	251	29.74	30.10	31.15	--
SH.Q-100	6	254	.33	.12	well plugged	
SH:Q-101	7	258	33.18	33.55	34.15	33.98
SH:Q-102	8A	262	--	43.65	44.48	43.98
	8	262	dry	dry	dry	well destroyed
SH:Q-103	9	275	dry	dry	dry	dry
SH:Q-104	10	267	dry	dry	dry	dry
SH:Q- 91	11	262	60.07	48.52	48.11	44.92
SH:Q-105	12	252	36.39	36.48	37.25	37.75
SH:Q-106	13	264	dry	dry	31.65	dry
SH:Q-107	14	264	23.1	25.36	25.86	25 59
SH:Q-108	15	260	39.07	38.12	39.38	39 81
SH:Q-109	16	257	31.01	31 08	31 54	31 28
SH:Q-110	17	255	30.46	30.58	--	30.59
SH:Q-111	18	259	35.56	35.64	36.08	35.42
SH:Q-112	19	247	20.98	21.05	21.97	20.54
SH.Q-113	20	248	31.50	31.66	32.14	32.18
SH.Q-114	21A	260	--	42.37	43.14	2.91
	21	260	dry	dry	dry	well destroyed
SH:Q-115	22	255	--	42.37	43.14	42.91
SH.Q-116	23	246	--	--	16.74	16.47
SH.Q-117	24	250	--	--	30.64	32.22
SH:Q-118	25	262	--	--	50.17	51.64
SH.Q-119	26	260	--	--	46.32	45.84
SH:Q-120	27	262	--	--	48.10	47 74
SH Q-121	28	273	--	--	--	20 03
SH:Q-128	30	250	--	--	--	34.30
SH.Q-129	31	249	--	--	--	32.94
SH:Q-122	C-1	247	--	33 39	--	--
SH:Q-123	C-2	247	--	22.12	--	--
SH:Q- 90	MS-1	247	35.08	37.01	--	--
SH:Q- 92	MS-2	247	--	28.88	--	--
SH:Q-125	MS-3	250	--	--	--	39.55

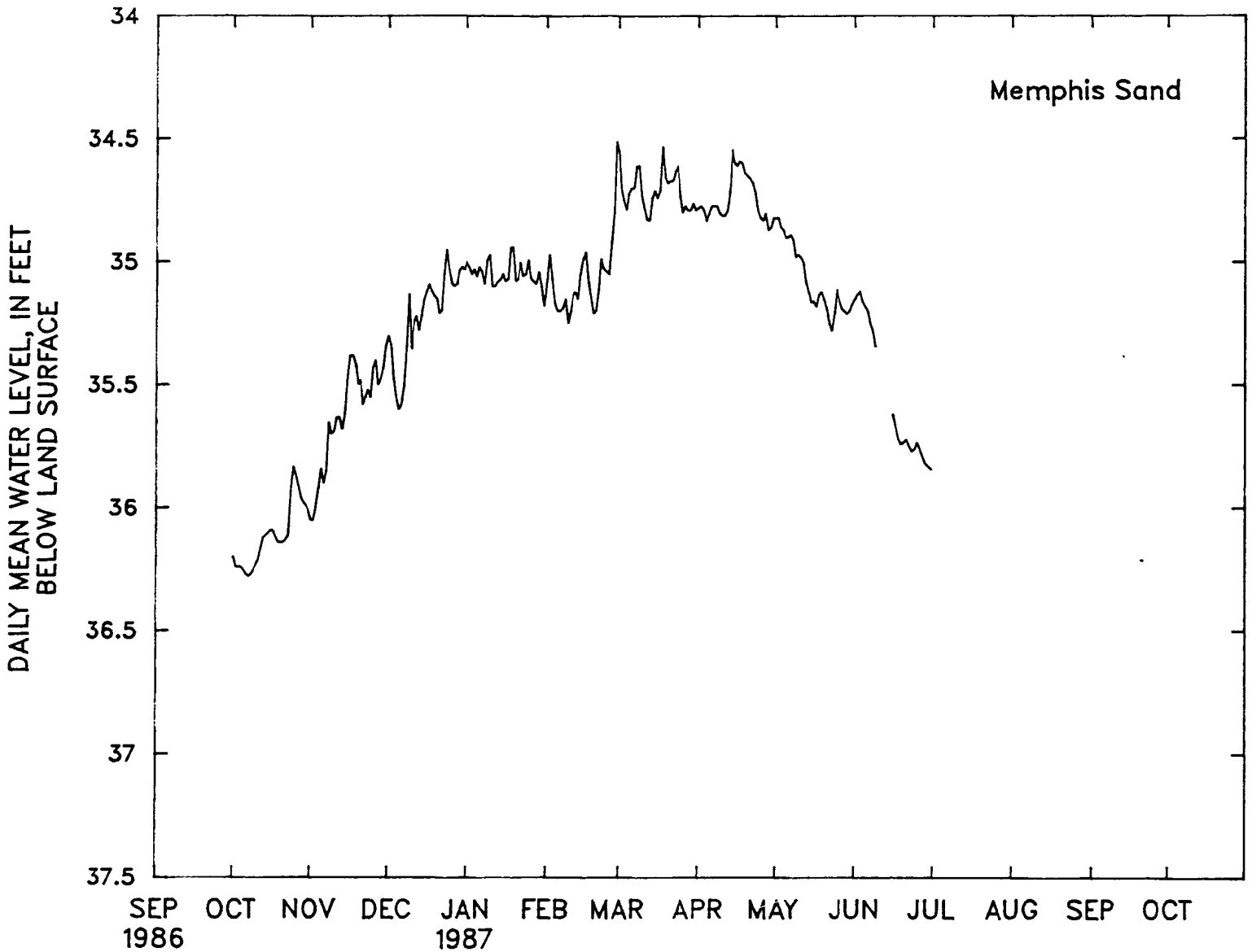


Figure 2.--Ground-water levels in well MS-1.

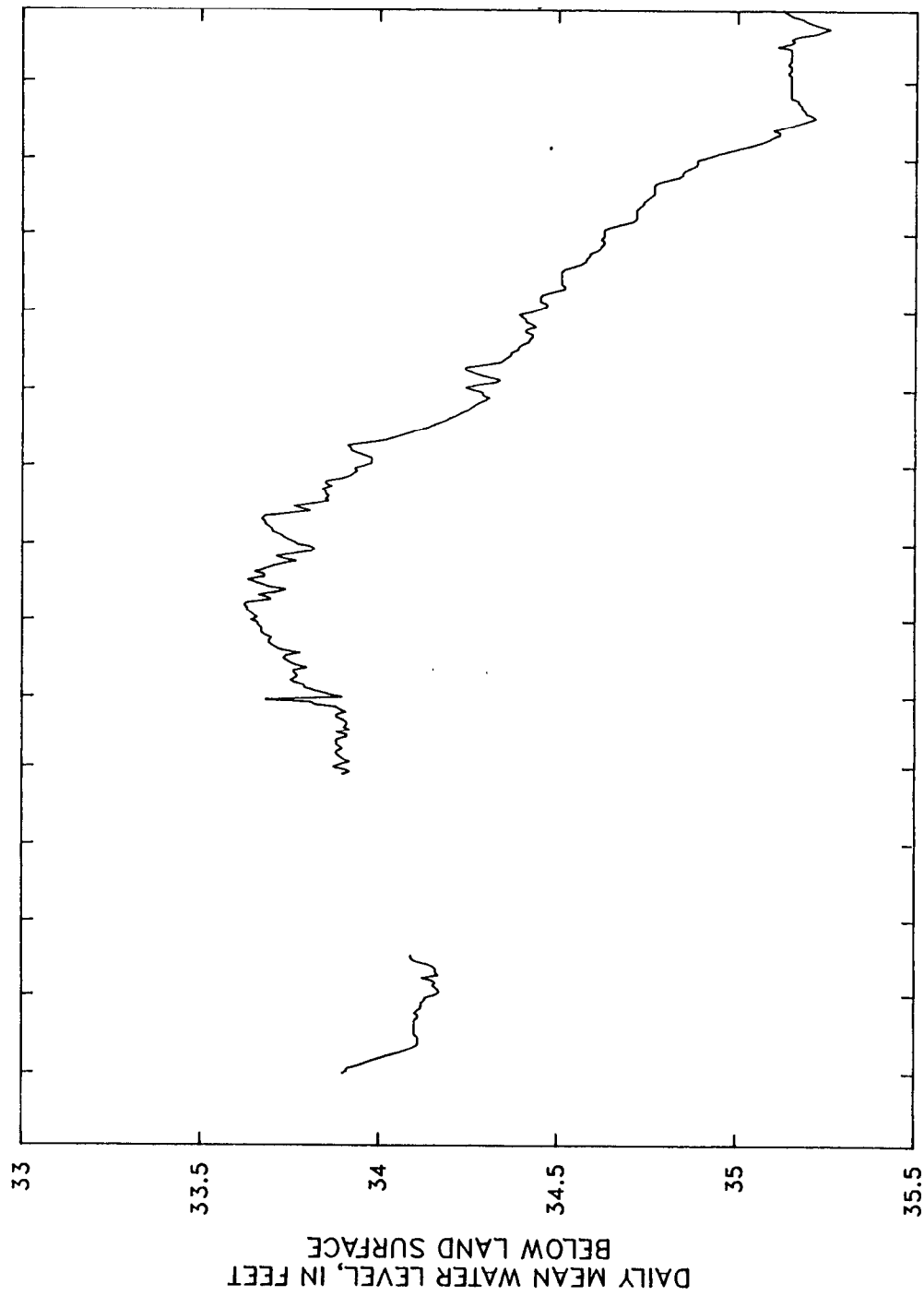


Figure 3.--Ground-water levels in well 7.

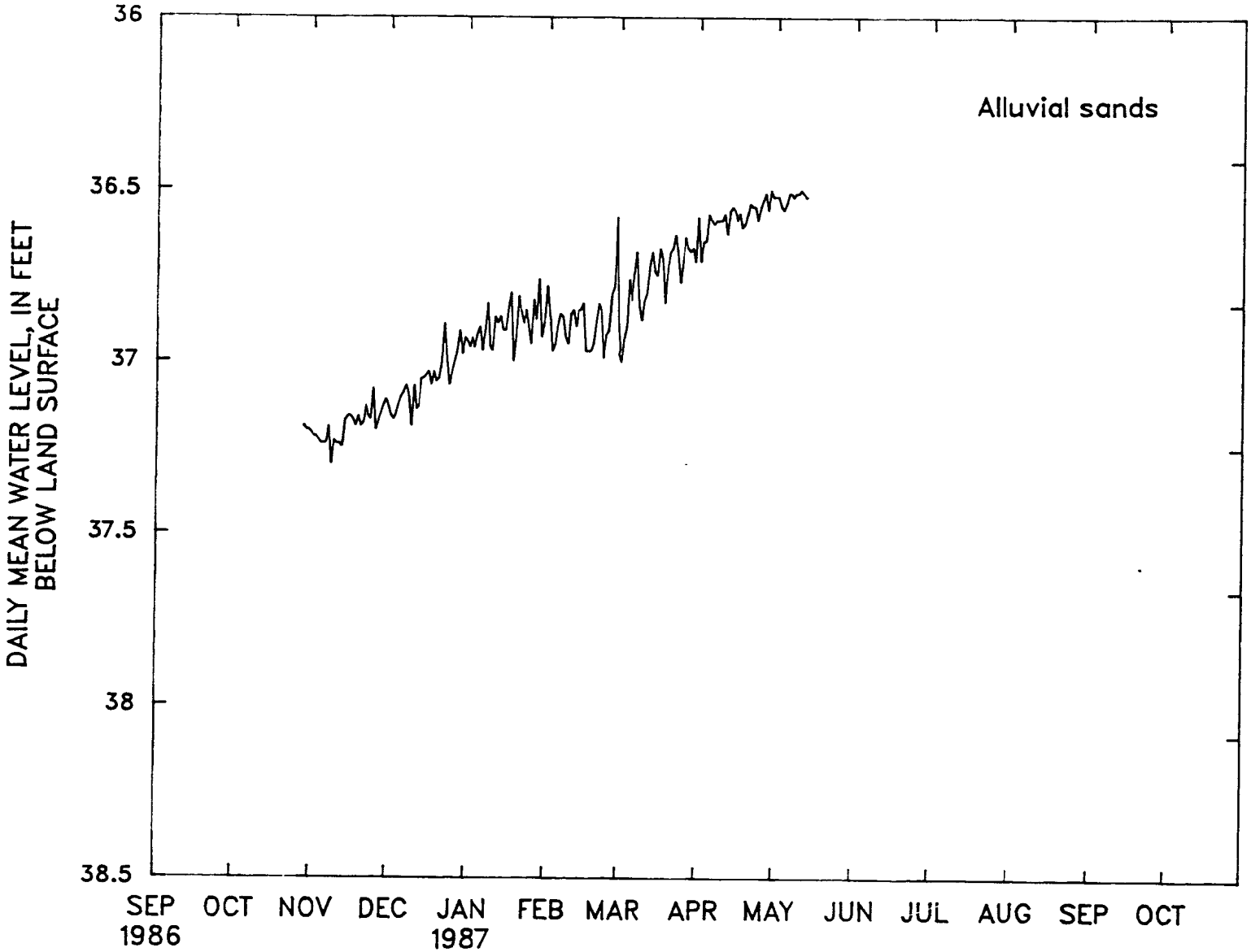


Figure 4.--Ground-water levels in well 22.

REFERENCE

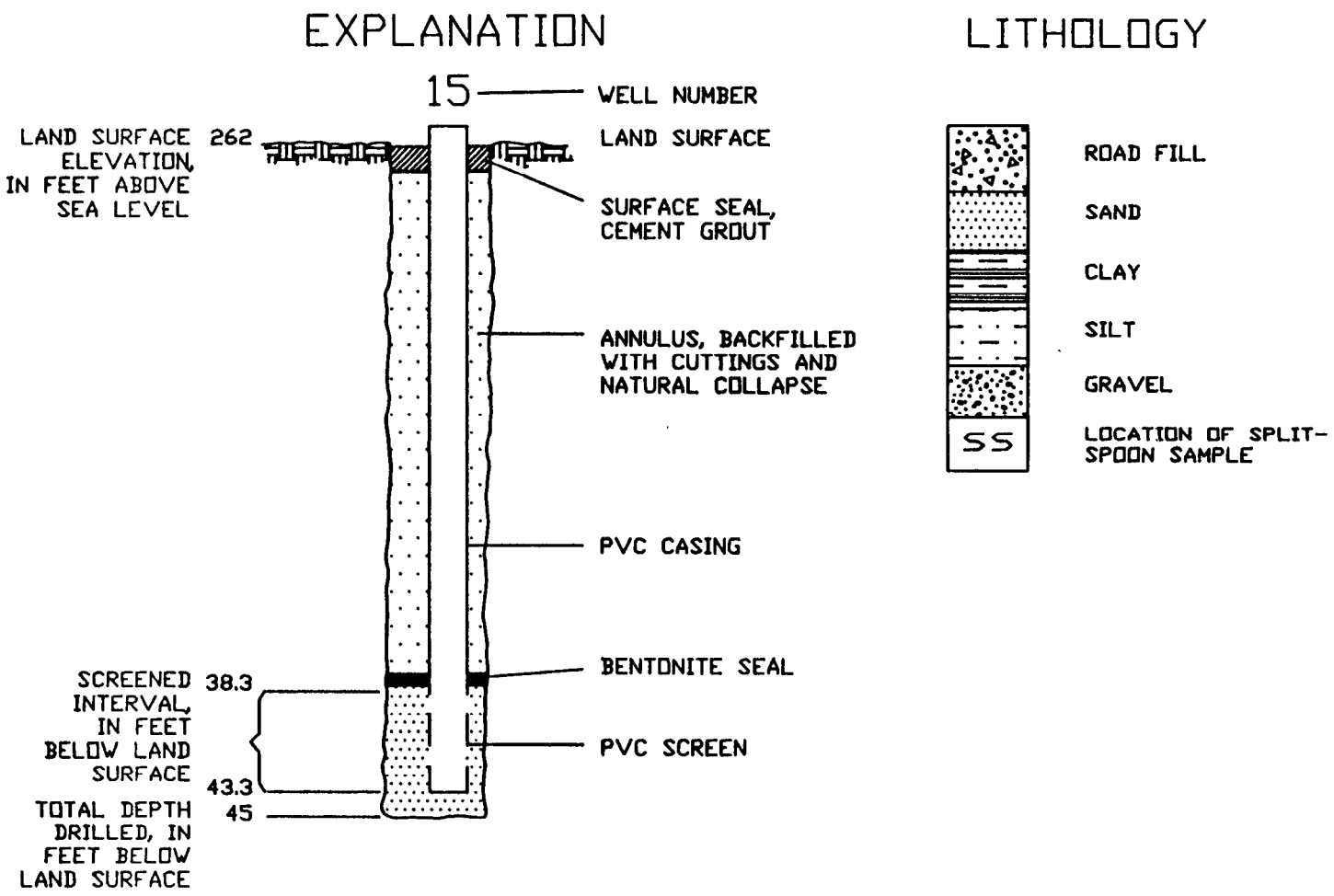
Graham, D.D., and Parks, W.S., 1986, Potential for leakage among principal aquifers in the Memphis area, Tennessee: U.S. Geological Survey Water-Resources Investigations Report 85-4295, 46 p.

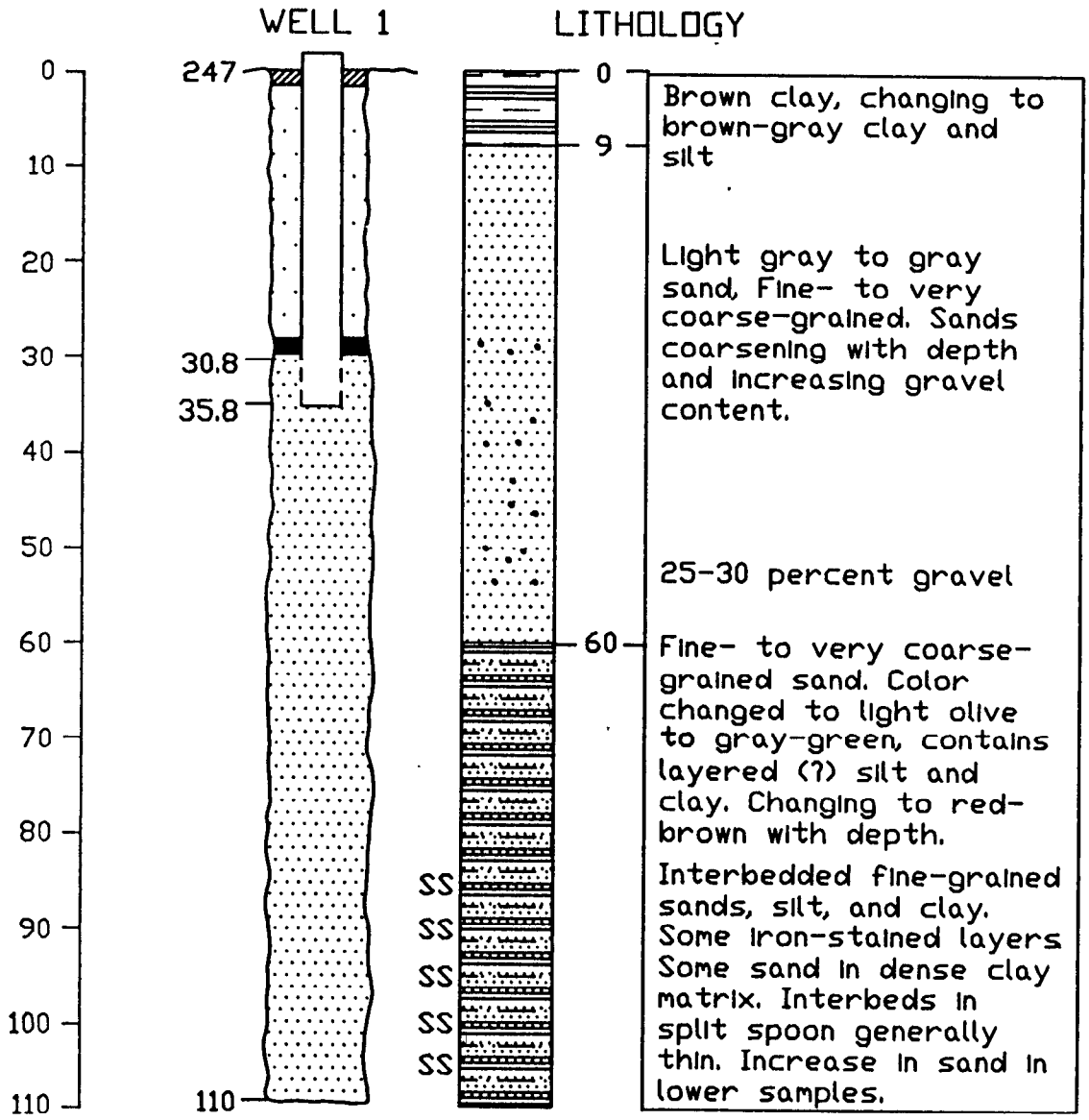
APPENDIX A

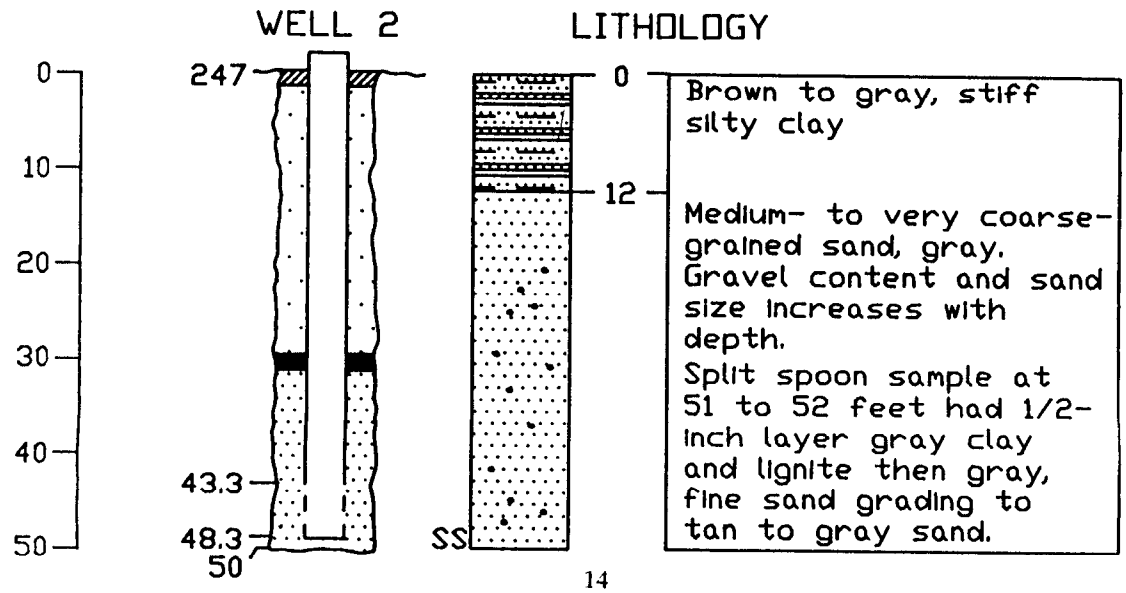
Well-construction diagrams, lithology, and gamma logs

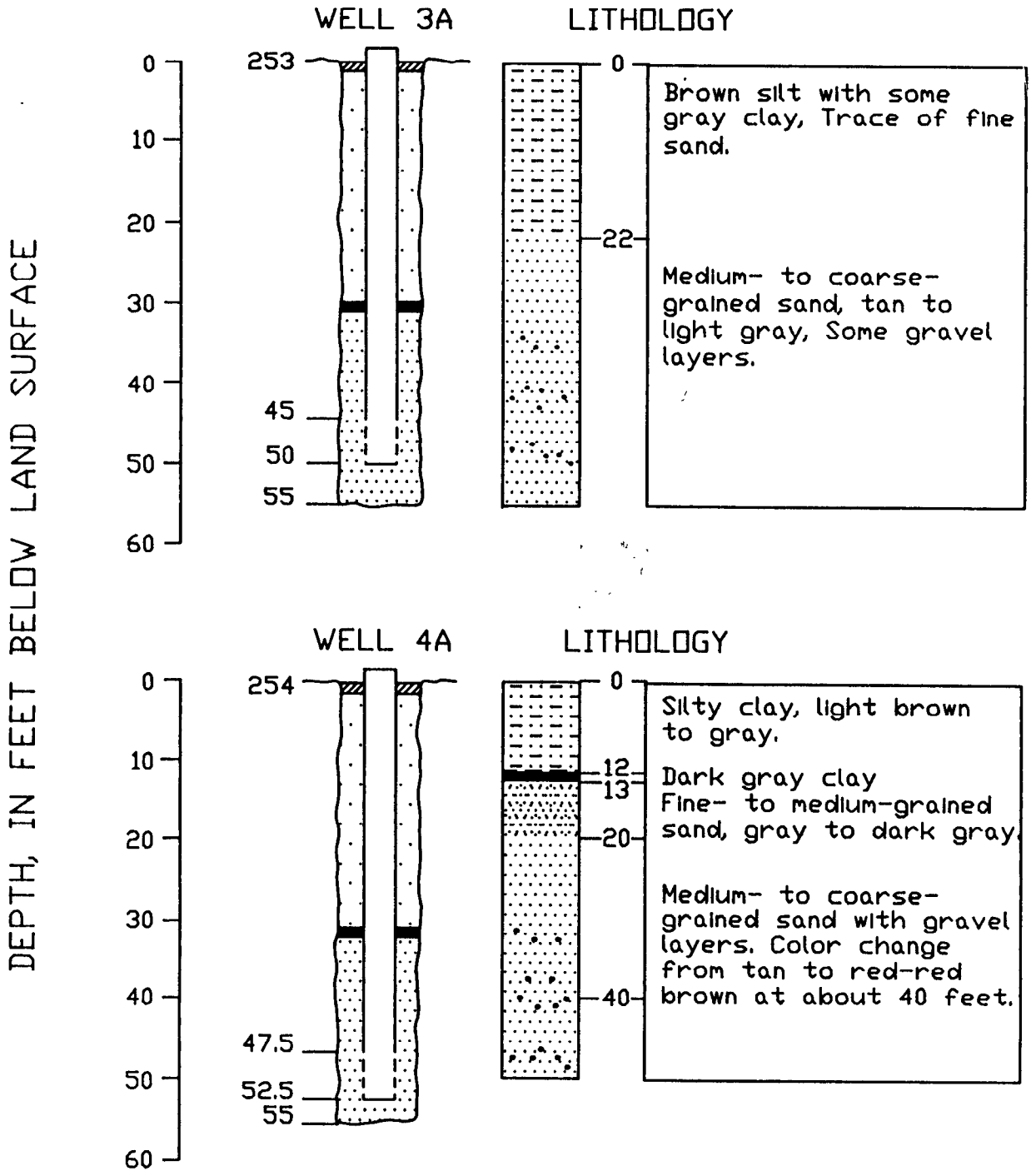
APPENDIX A

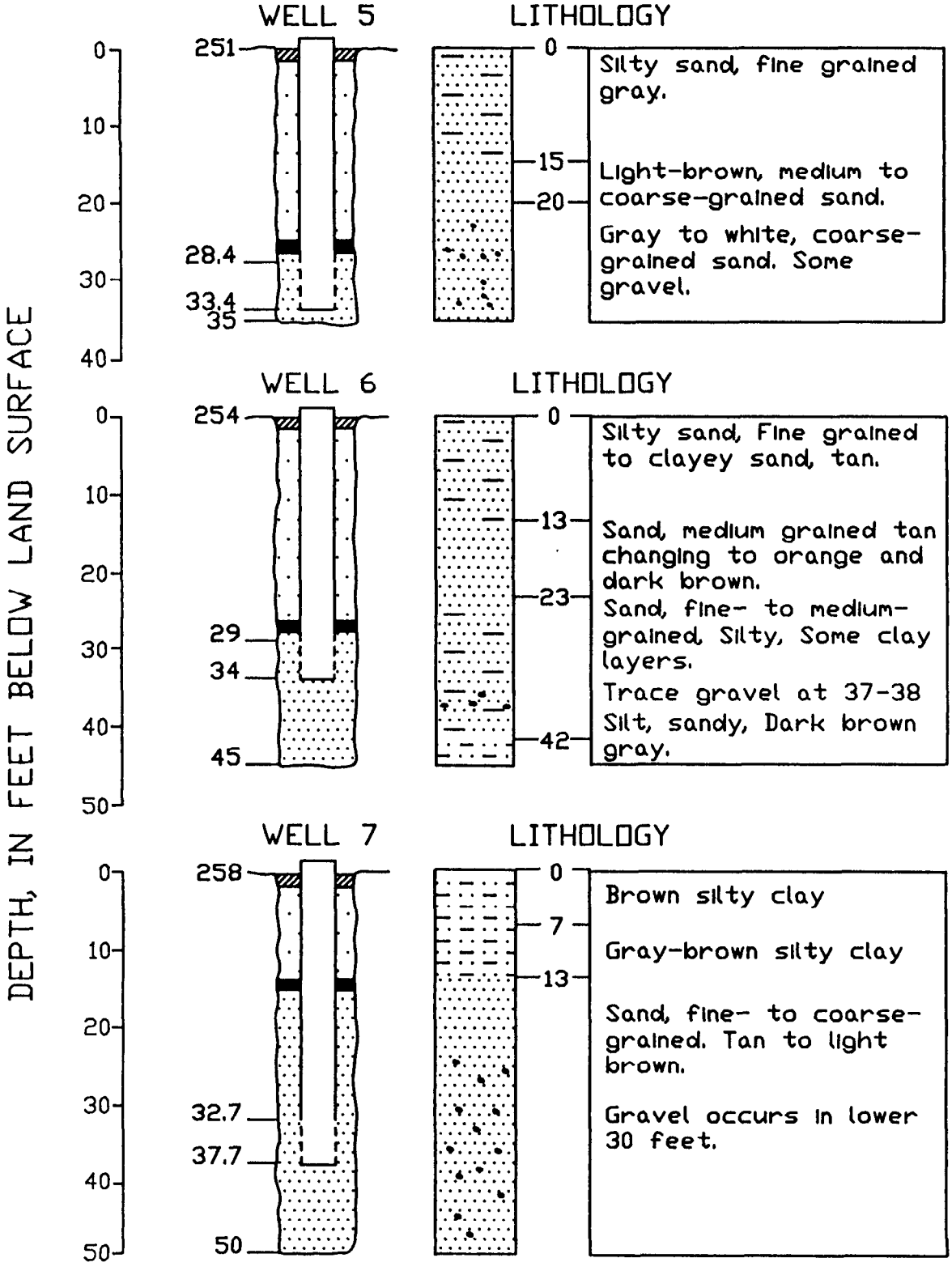
Well-construction diagrams, lithology, and gamma logs

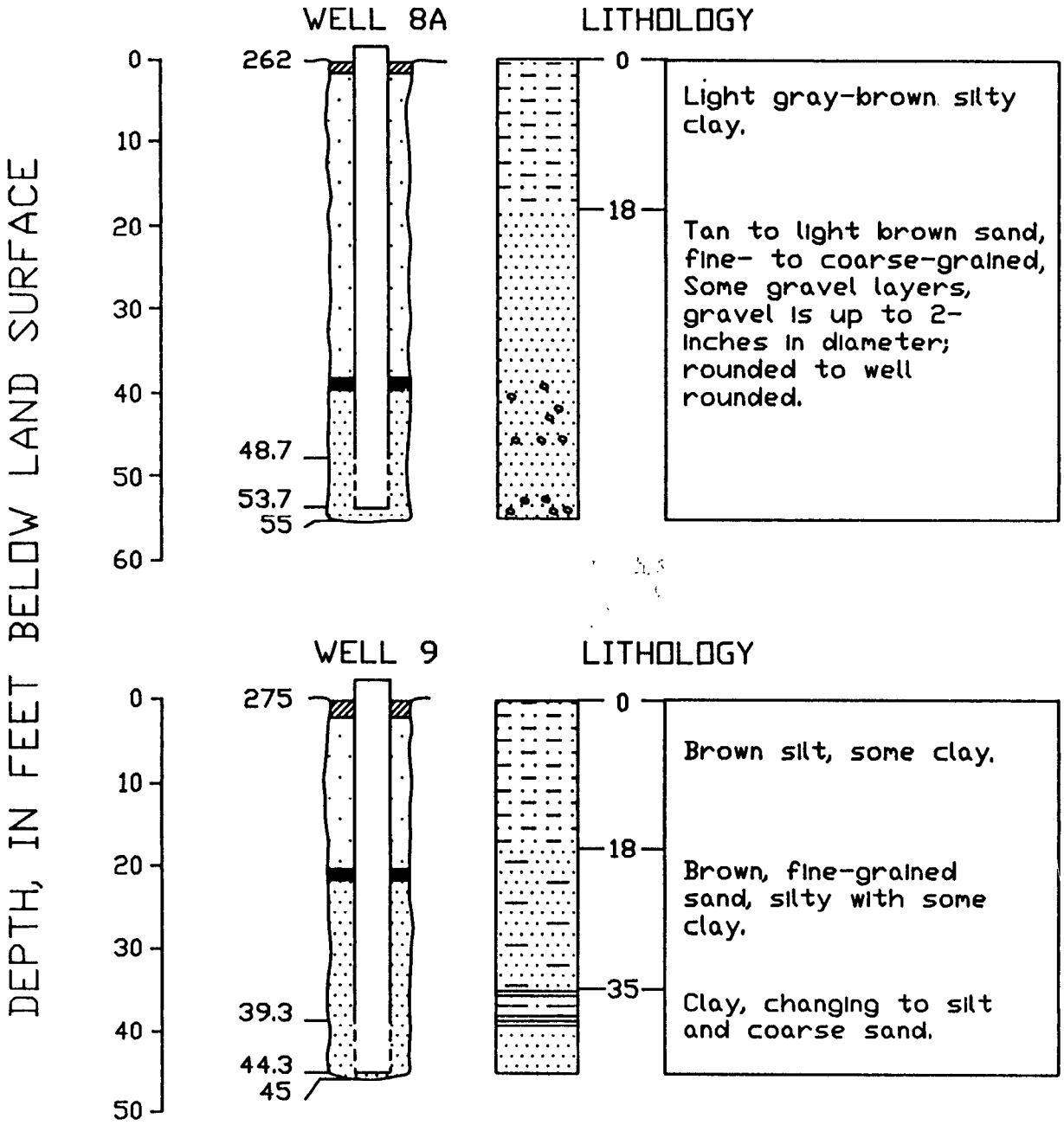


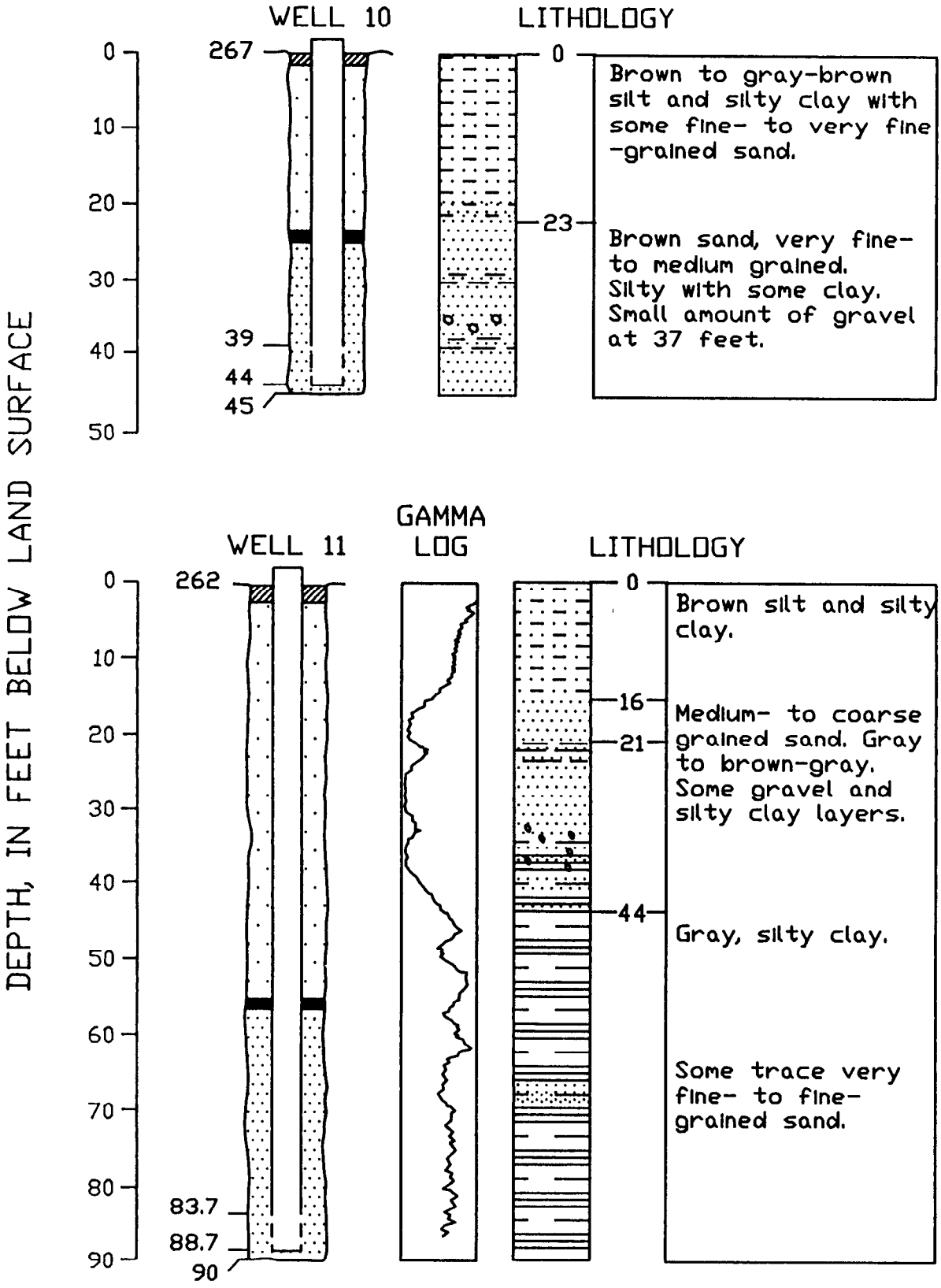

WELL 1
LITHOLOGY
0
10
20
30
40
50
60
70
80
90
100
110
247
30.8
35.8
110
SS
SS
SS
SS
SS
0
9
60
Brown clay, changing to brown-gray clay and silt
Light gray to gray sand, Fine- to very coarse-grained. Sands coarsening with depth and increasing gravel content.
25-30 percent gravel
Fine- to very coarse-grained sand. Color changed to light olive to gray-green, contains layered (?) silt and clay. Changing to red-brown with depth.
Interbedded fine-grained sands, silt, and clay. Some iron-stained layers Some sand in dense clay matrix. Interbeds in split spoon generally thin. Increase in sand in lower samples.

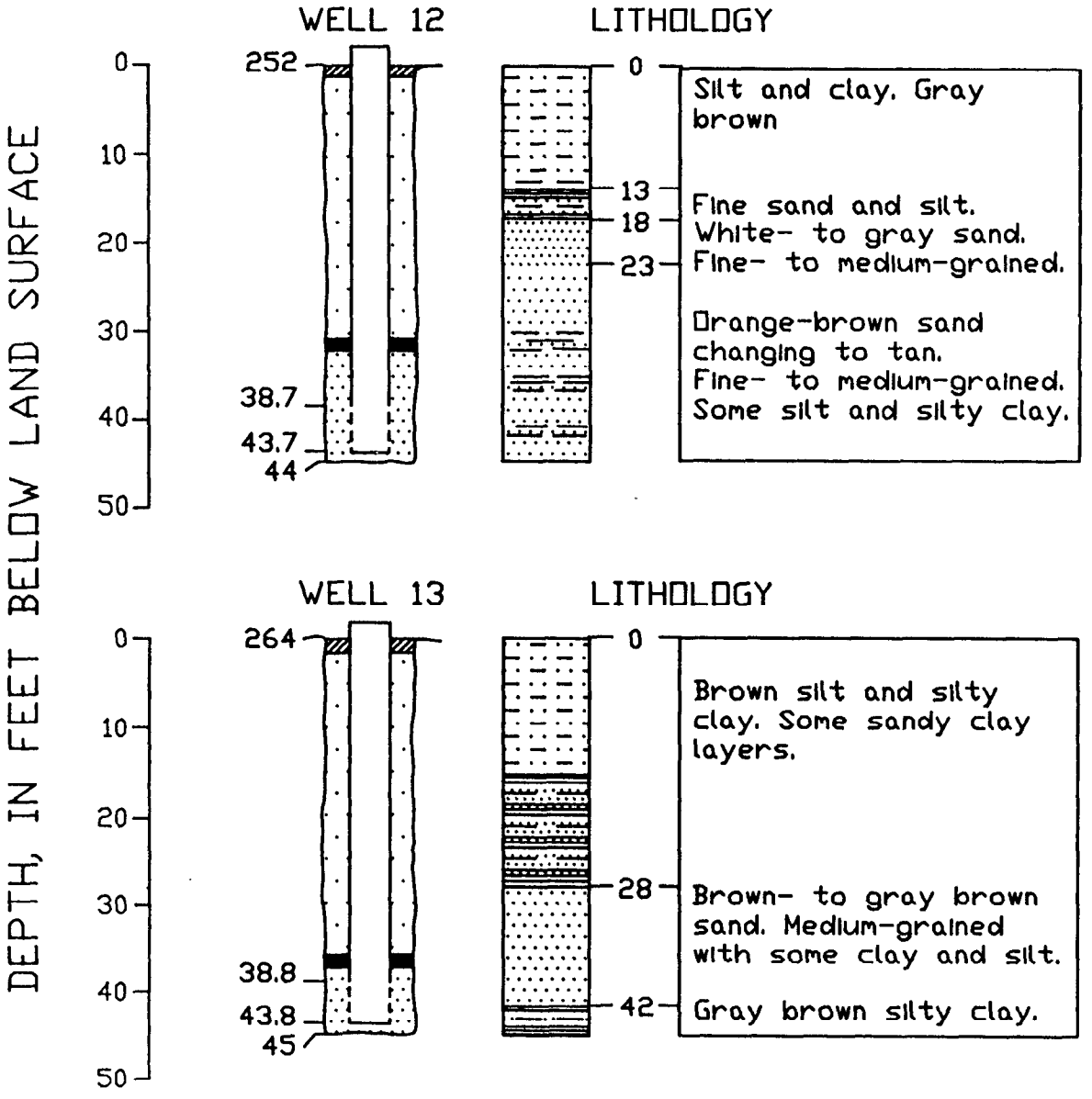

WELL 2
LITHOLOGY
0
10
20
30
40
50
247
43.3
48.3
50
SS
0
12
Brown to gray, stiff silty clay
Medium- to very coarse-grained sand, gray. Gravel content and sand size increases with depth.
Split spoon sample at 51 to 52 feet had 1/2-inch layer gray clay and lignite then gray, fine sand grading to tan to gray sand.

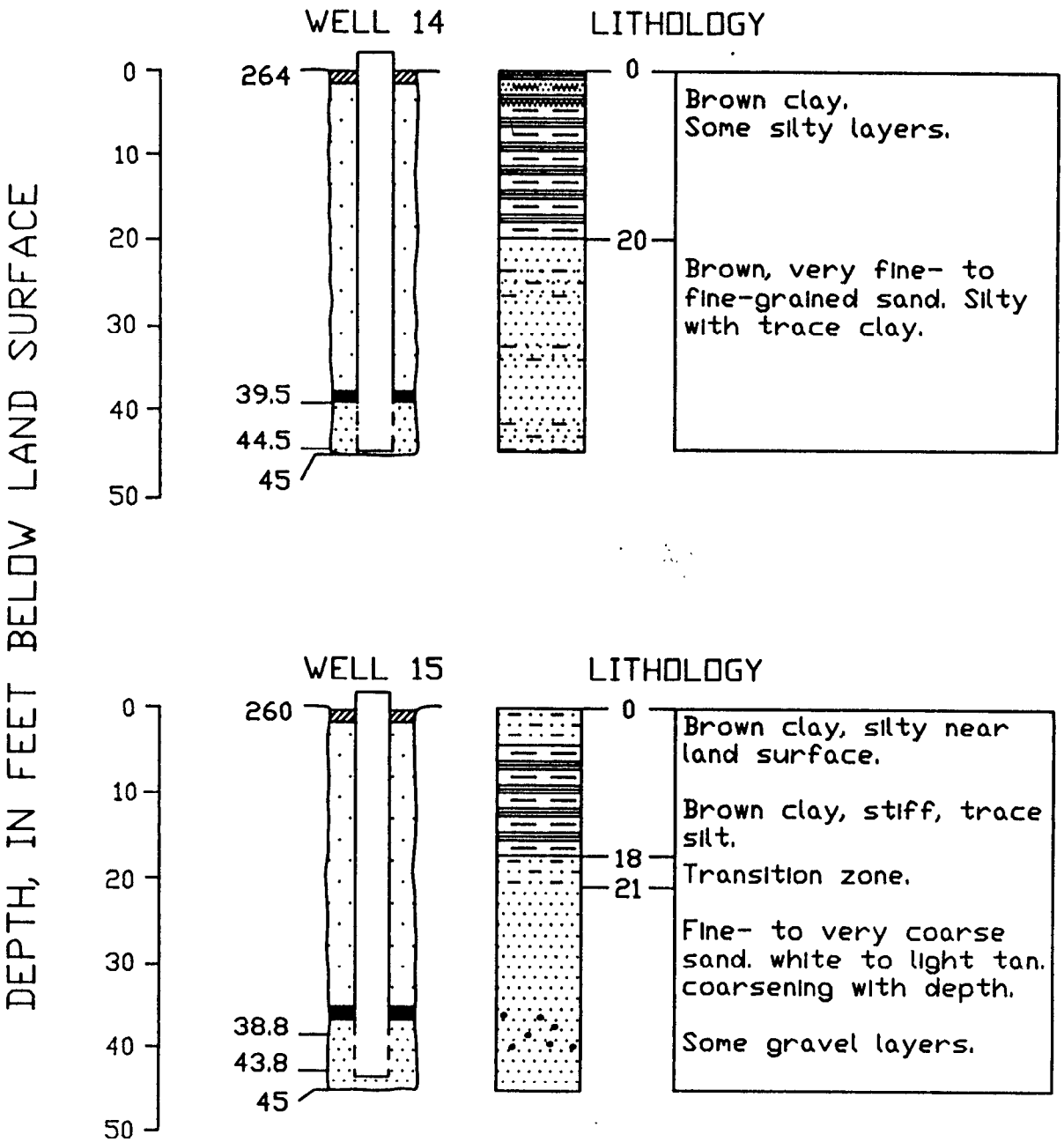

DEPTH, IN FEET BELOW LAND SURFACE
WELL 3A
LITHOLOGY
0
10
20
30
40
50
60
253
45
50
55
0
22
Brown silt with some gray clay, Trace of fine sand.
Medium- to coarse-grained sand, tan to light gray, Some gravel layers.
WELL 4A
LITHOLOGY
254
47.5
52.5
55
0
12
13
20
40
Silty clay, light brown to gray.
Dark gray clay
Fine- to medium-grained sand, gray to dark gray.
Medium- to coarse-grained sand with gravel layers. Color change from tan to red-red brown at about 40 feet.

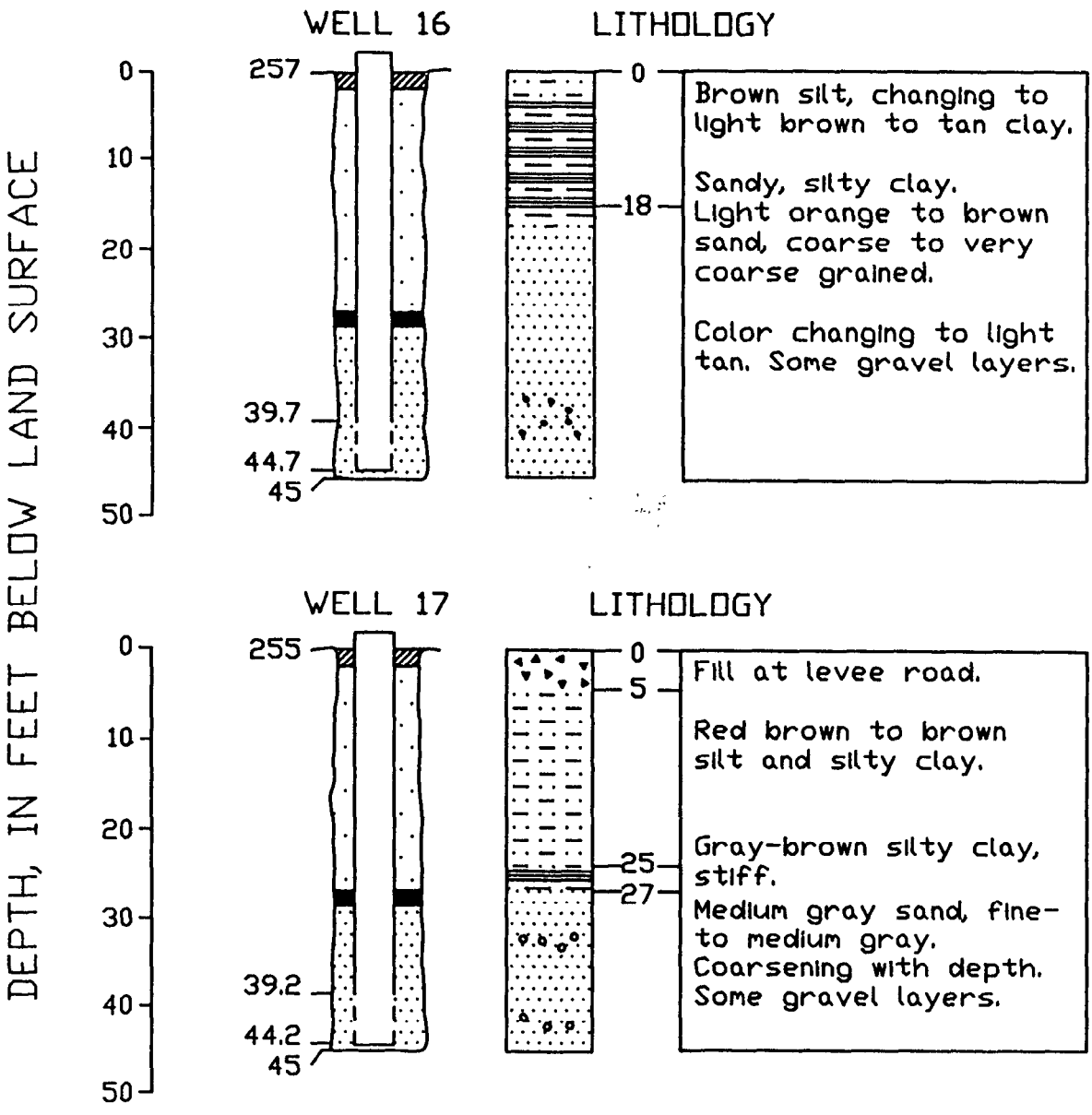

DEPTH, IN FEET BELOW LAND SURFACE
WELL 5
LITHOLOGY
0
10
20
30
40
251
28.4
33.4
35
0
15
20
Silty sand, fine grained gray.
Light-brown, medium to coarse-grained sand.
Gray to white, coarse-grained sand. Some gravel.
WELL 6
LITHOLOGY
0
10
20
30
40
50
254
29
34
45
0
13
23
42
Silty sand, Fine grained to clayey sand, tan.
Sand, medium grained tan changing to orange and dark brown.
Sand, fine- to medium-grained, Silty, Some clay layers.
Trace gravel at 37-38
Silt, sandy, Dark brown gray.
WELL 7
LITHOLOGY
0
10
20
30
40
50
258
32.7
37.7
50
0
7
13
Brown silty clay
Gray-brown silty clay
Sand, fine- to coarse-grained. Tan to light brown.
Gravel occurs in lower 30 feet.

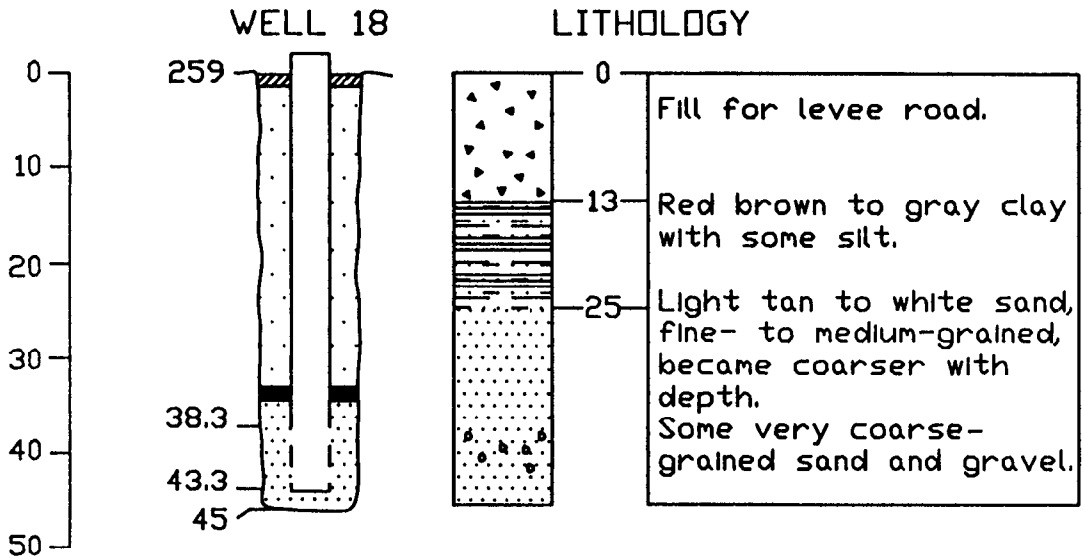

DEPTH, IN FEET BELOW LAND SURFACE
WELL 8A
LITHOLOGY
0
10
20
30
40
50
60
262
48.7
53.7
55
0
18
Light gray-brown silty clay.
Tan to light brown sand, fine- to coarse-grained, Some gravel layers, gravel is up to 2-inches in diameter; rounded to well rounded.
WELL 9
LITHOLOGY
0
10
20
30
40
50
275
39.3
44.3
45
0
18
35
Brown silt, some clay.
Brown, fine-grained sand, silty with some clay.
Clay, changing to silt and coarse sand.

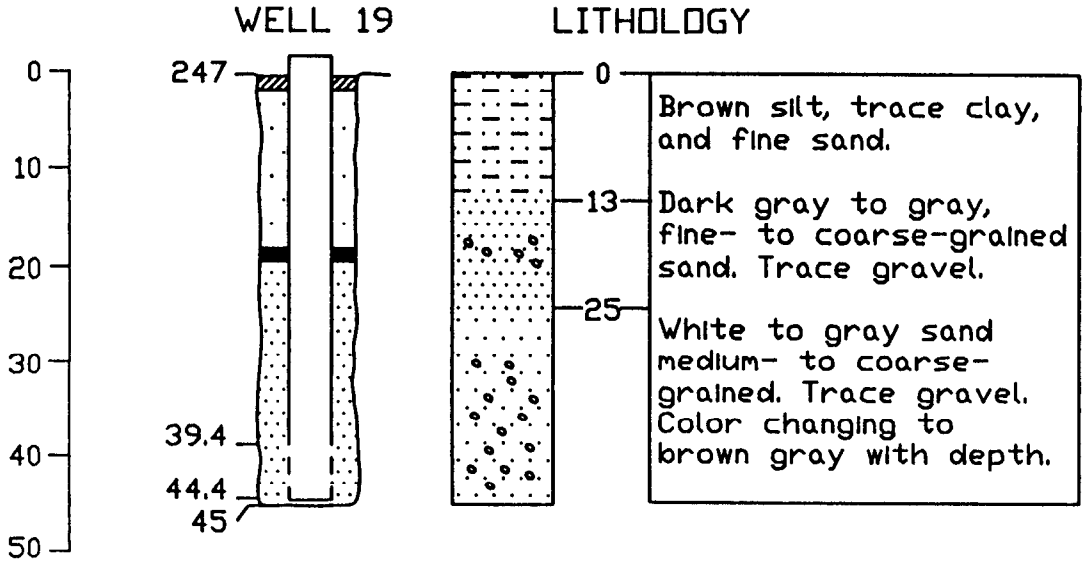

DEPTH, IN FEET BELOW LAND SURFACE
WELL 10
LITHOLOGY
0
10
20
30
40
50
267
39
44
45
0
23
Brown to gray-brown silt and silty clay with some fine- to very fine -grained sand.
Brown sand, very fine- to medium grained. Silty with some clay. Small amount of gravel at 37 feet.
WELL 11
GAMMA LOG
LITHOLOGY
0
10
20
30
40
50
60
70
80
90
262
83.7
88.7
90
0
16
21
44
Brown silt and silty clay.
Medium- to coarse grained sand. Gray to brown-gray. Some gravel and silty clay layers.
Gray, silty clay.
Some trace very fine- to fine-grained sand.

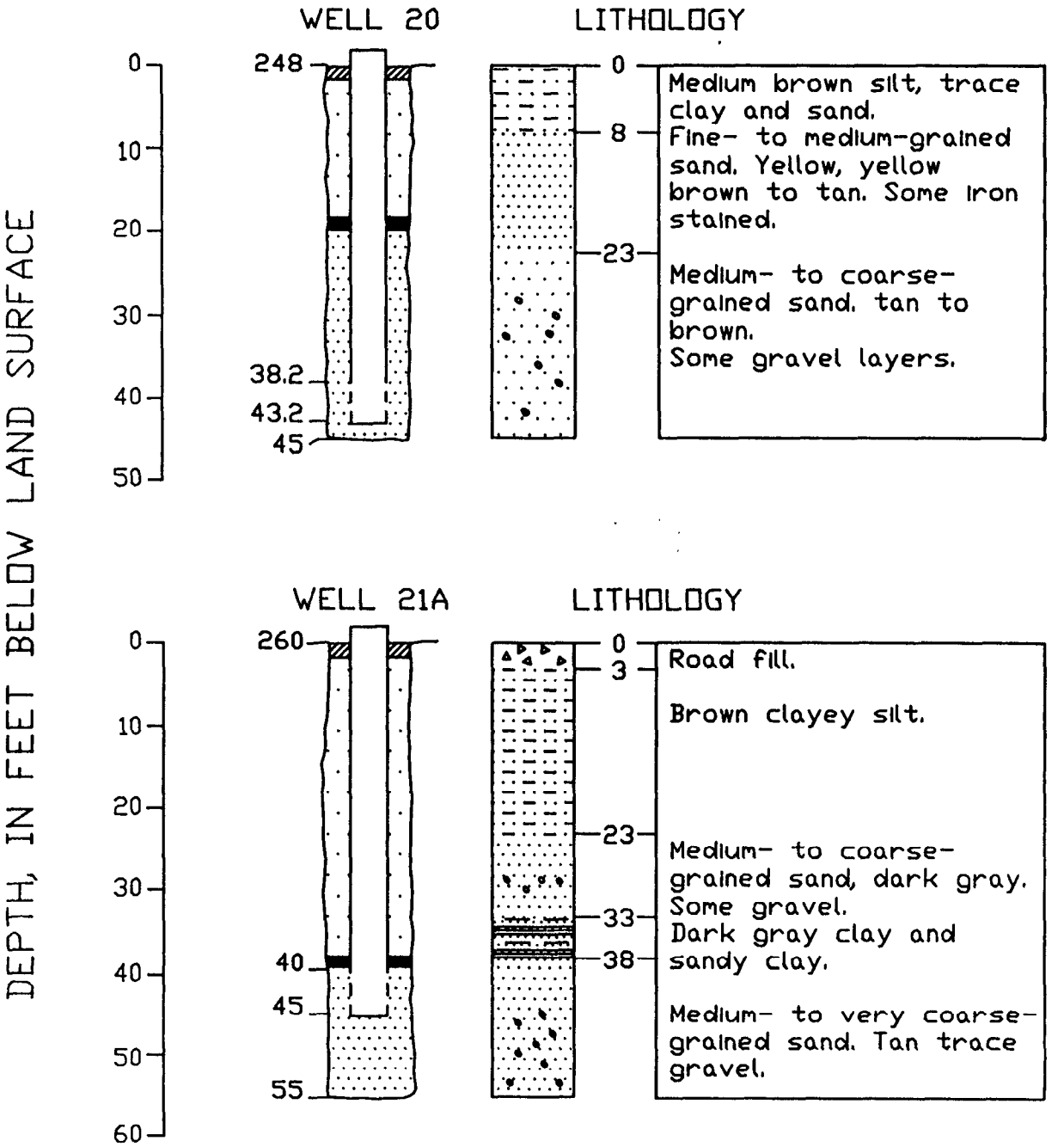

DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
50
WELL 12
252
38.7
43.7
44
LITHOLOGY
0
13
18
23
Silt and clay. Gray brown
Fine sand and silt. White- to gray sand. Fine- to medium-grained.
Orange-brown sand changing to tan. Fine- to medium-grained. Some silt and silty clay.
WELL 13
264
38.8
43.8
45
LITHOLOGY
0
28
42
Brown silt and silty clay. Some sandy clay layers.
Brown- to gray brown sand. Medium-grained with some clay and silt.
Gray brown silty clay.

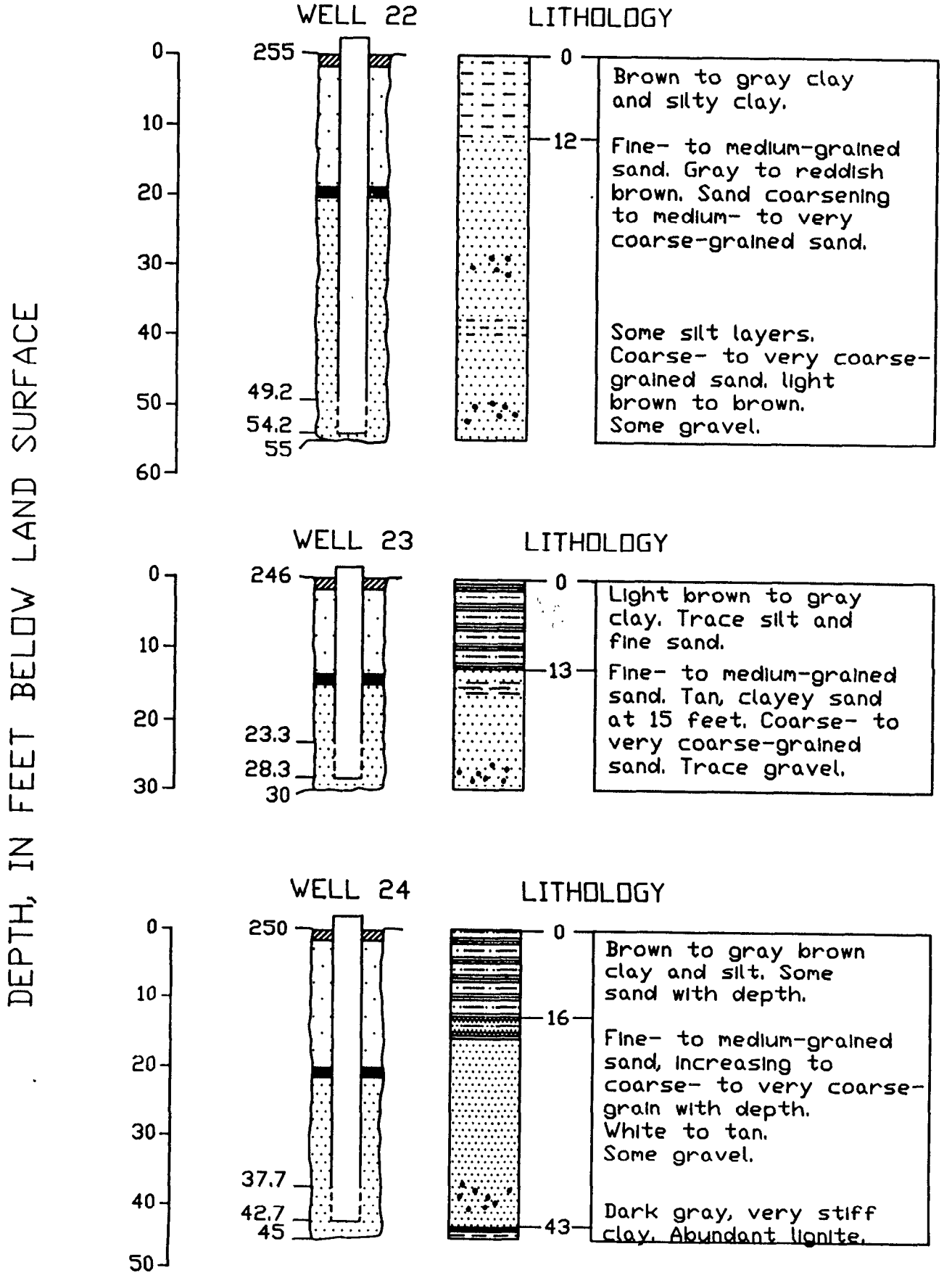

WELL 14
LITHOLOGY
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
50
264
39.5
44.5
45
0
20
Brown clay.
Some silty layers.
Brown, very fine- to fine-grained sand. Silty with trace clay.
WELL 15
LITHOLOGY
260
38.8
43.8
45
0
18
21
Brown clay, silty near land surface.
Brown clay, stiff, trace silt.
Transition zone.
Fine- to very coarse sand. white to light tan. coarsening with depth.
Some gravel layers.

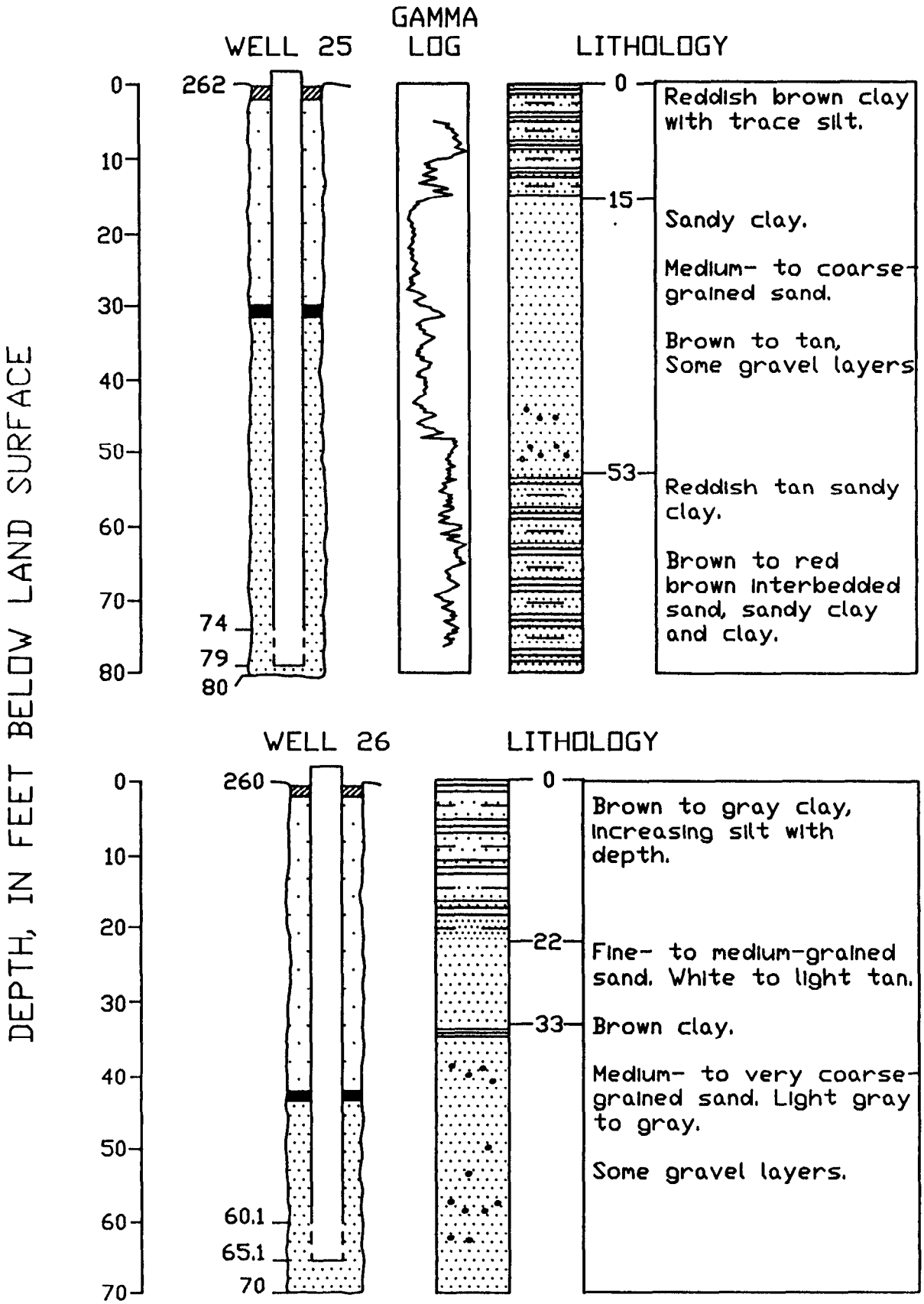

DEPTH, IN FEET BELOW LAND SURFACE
WELL 16
LITHOLOGY
257
0
10
20
30
40
50
39.7
44.7
45
0
18
Brown silt, changing to light brown to tan clay.
Sandy, silty clay. Light orange to brown sand, coarse to very coarse grained.
Color changing to light tan. Some gravel layers.
WELL 17
LITHOLOGY
255
0
5
25
27
39.2
44.2
45
Fill at levee road.
Red brown to brown silt and silty clay.
Gray-brown silty clay, stiff.
Medium gray sand, fine- to medium gray. Coarsening with depth. Some gravel layers.

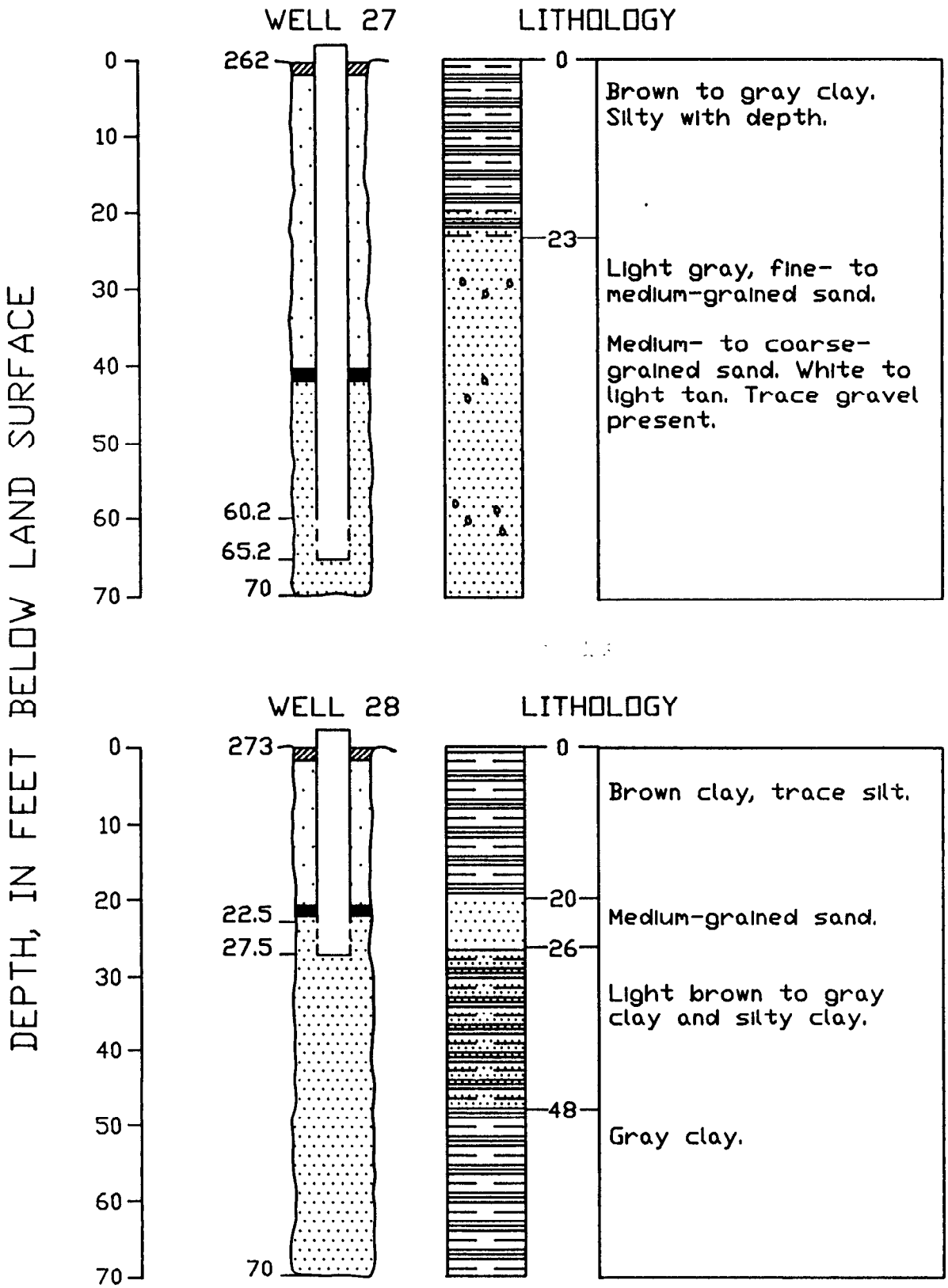

WELL 18
LITHOLOGY
0
10
20
30
40
50
259
38.3
43.3
45
0
13
25
Fill for levee road.
Red brown to gray clay with some silt.
Light tan to white sand, fine- to medium-grained, became coarser with depth.
Some very coarse-grained sand and gravel.

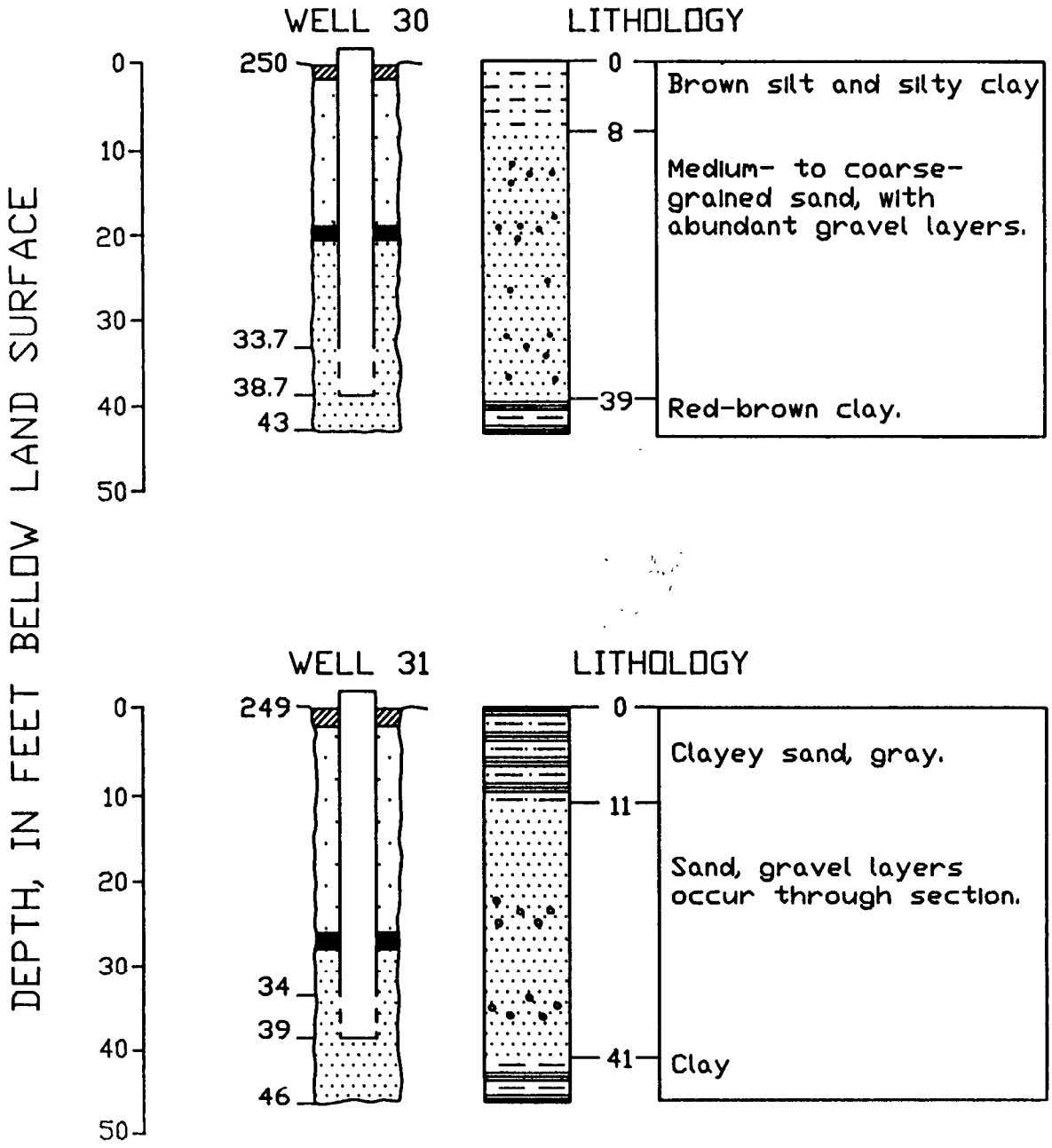

WELL 19
LITHOLOGY
0
10
20
30
40
50
247
39.4
44.4
45
0
13
25
Brown silt, trace clay, and fine sand.
Dark gray to gray, fine- to coarse-grained sand. Trace gravel.
White to gray sand medium- to coarse-grained. Trace gravel. Color changing to brown gray with depth.

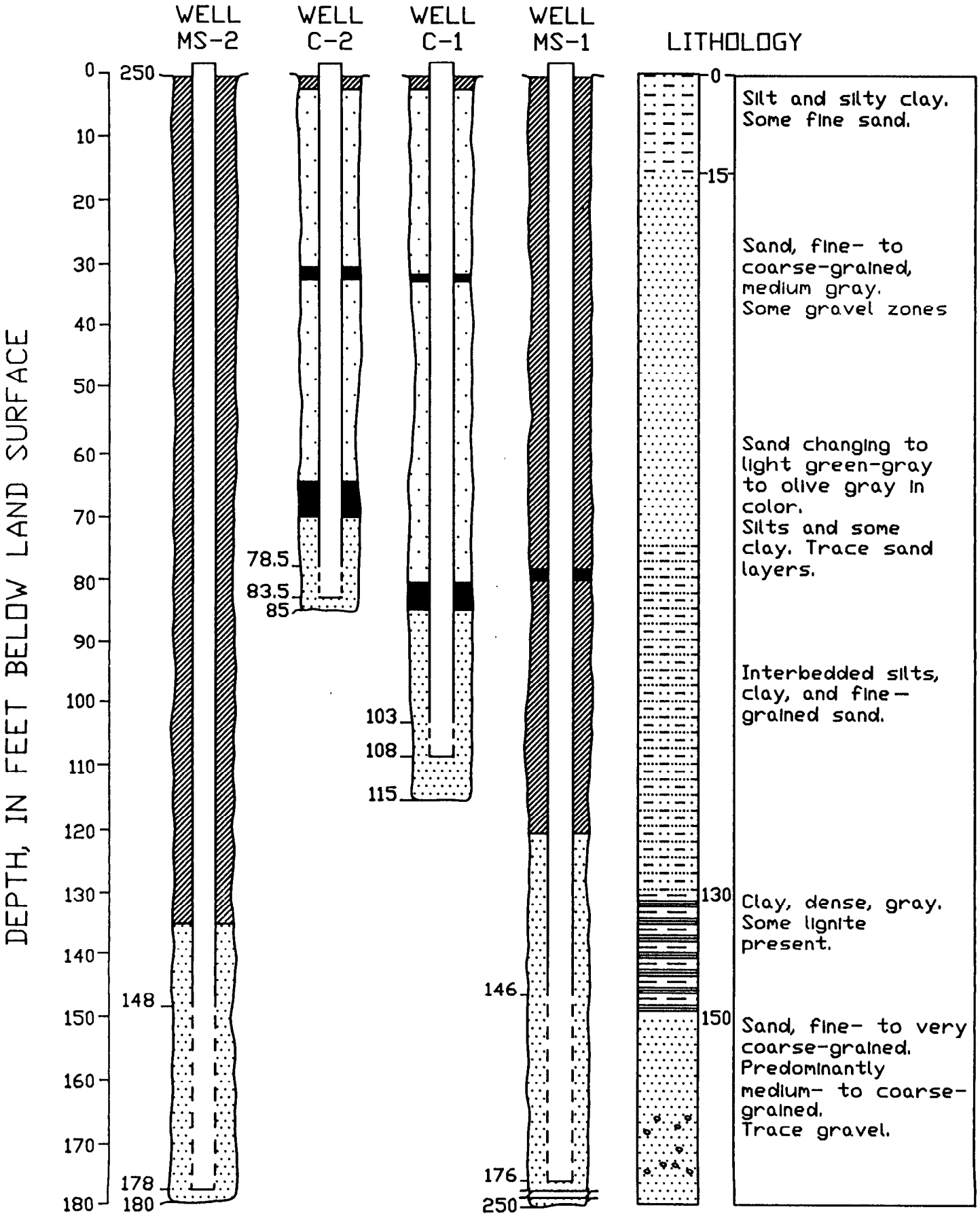

WELL 20
LITHOLOGY
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
50
248
38.2
43.2
45
0
8
23
Medium brown silt, trace clay and sand.
Fine- to medium-grained sand. Yellow, yellow brown to tan. Some iron stained.
Medium- to coarse-grained sand. tan to brown.
Some gravel layers.
WELL 21A
LITHOLOGY
0
10
20
30
40
50
60
260
40
45
55
0
3
23
33
38
Road fill.
Brown clayey silt.
Medium- to coarse-grained sand, dark gray.
Some gravel.
Dark gray clay and sandy clay.
Medium- to very coarse-grained sand. Tan trace gravel.

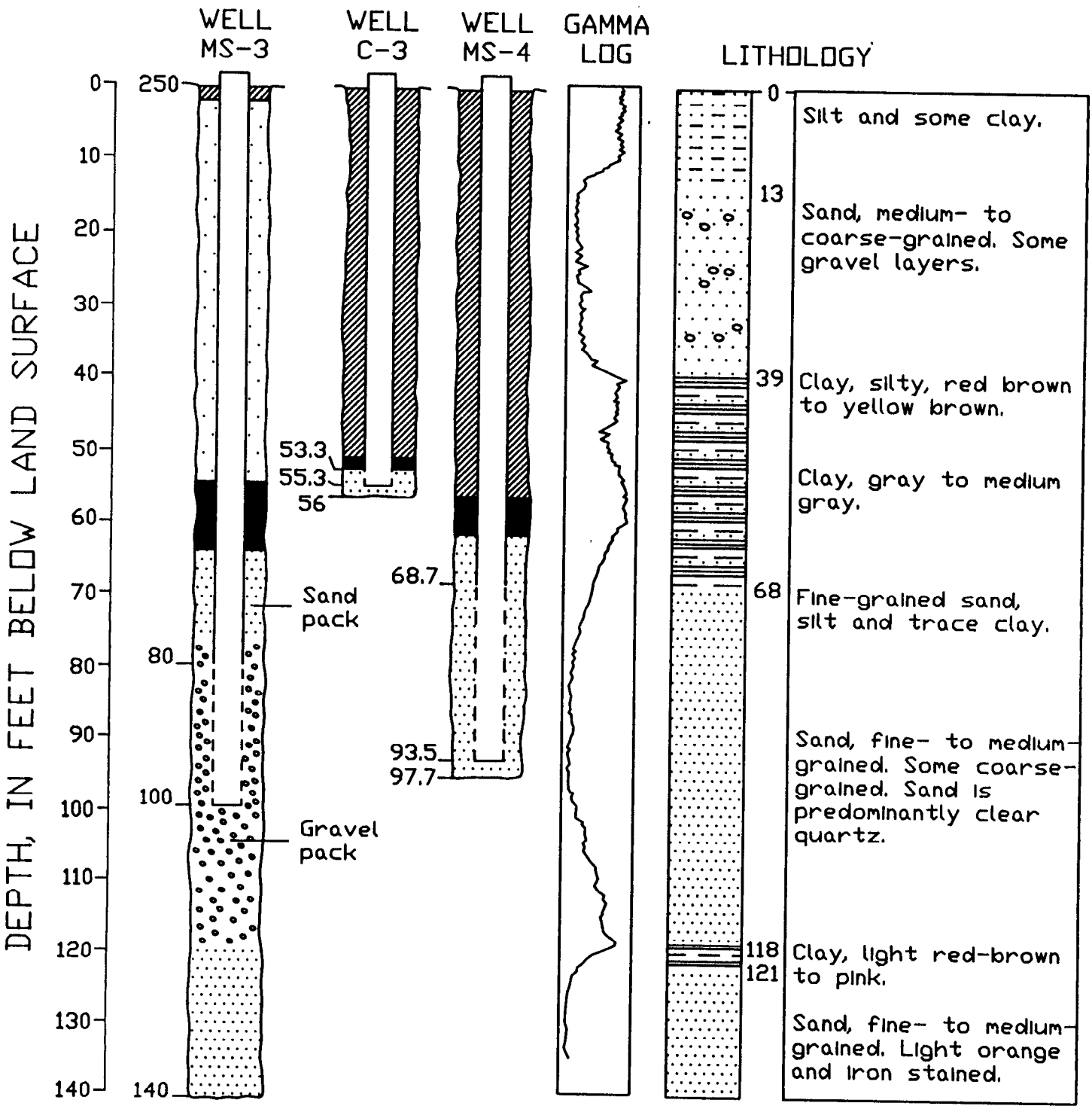

DEPTH, IN FEET BELOW LAND SURFACE
WELL 22
LITHOLOGY
0
10
20
30
40
50
60
255
49.2
54.2
55
0
12
Brown to gray clay and silty clay.
Fine- to medium-grained sand. Gray to reddish brown. Sand coarsening to medium- to very coarse-grained sand.
Some silt layers. Coarse- to very coarse-grained sand. light brown to brown. Some gravel.
WELL 23
LITHOLOGY
0
10
20
30
246
23.3
28.3
30
0
13
Light brown to gray clay. Trace silt and fine sand.
Fine- to medium-grained sand. Tan, clayey sand at 15 feet. Coarse- to very coarse-grained sand. Trace gravel.
WELL 24
LITHOLOGY
0
10
20
30
40
50
250
37.7
42.7
45
0
16
43
Brown to gray brown clay and silt. Some sand with depth.
Fine- to medium-grained sand, increasing to coarse- to very coarse-grain with depth. White to tan. Some gravel.
Dark gray, very stiff clay. Abundant lignite.


DEPTH, IN FEET BELOW LAND SURFACE
WELL 25
GAMMA LOG
LITHOLOGY
0
10
20
30
40
50
60
70
80
262
74
79
80
0
15
53
Reddish brown clay with trace silt.
Sandy clay.
Medium- to coarse-grained sand.
Brown to tan, Some gravel layers
Reddish tan sandy clay.
Brown to red brown interbedded sand, sandy clay and clay.
WELL 26
LITHOLOGY
260
60.1
65.1
70
0
22
33
Brown to gray clay, increasing silt with depth.
Fine- to medium-grained sand. White to light tan.
Brown clay.
Medium- to very coarse-grained sand. Light gray to gray.
Some gravel layers.

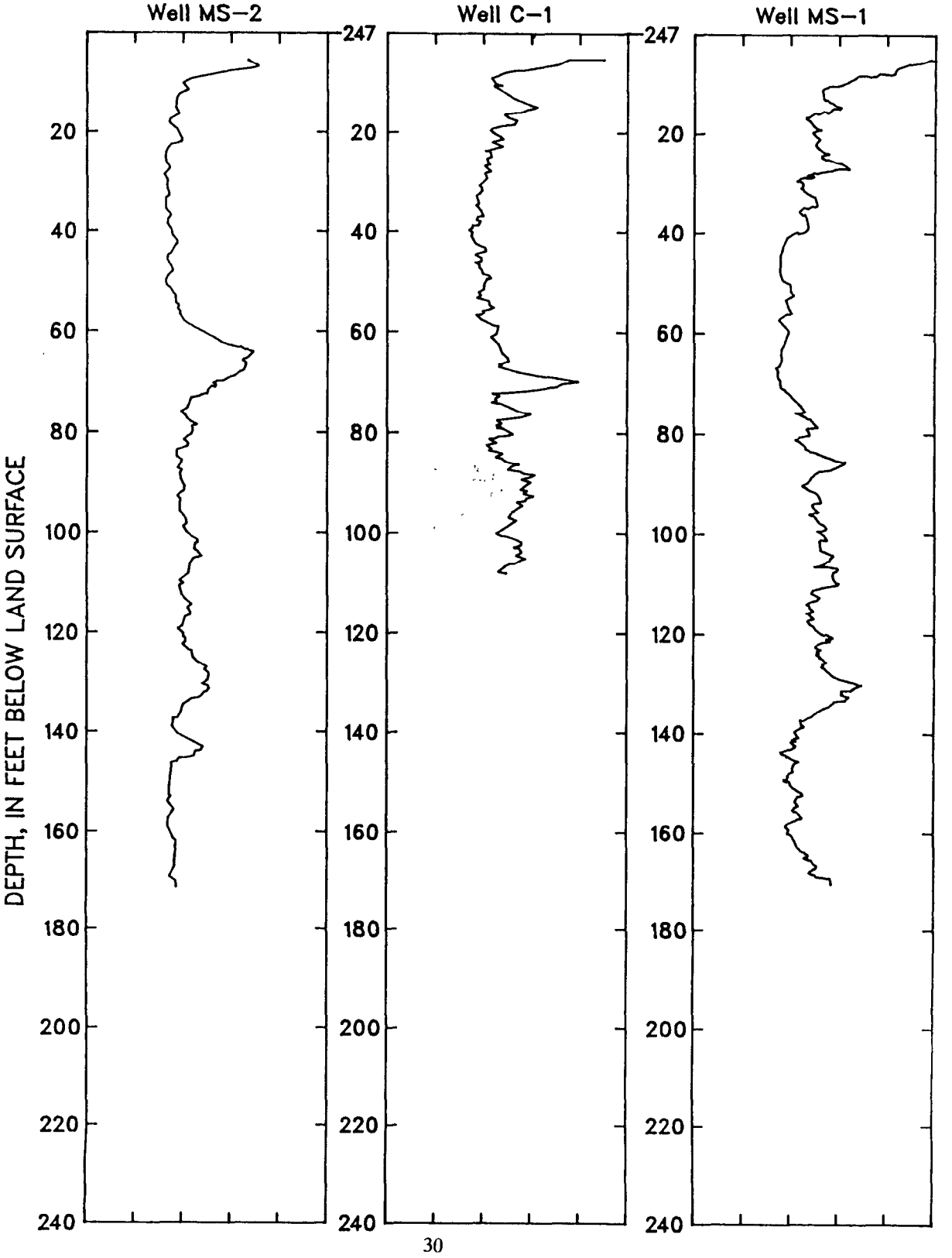

WELL 27
LITHOLOGY
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
50
60
70
262
60.2
65.2
70
0
23
Brown to gray clay. Silty with depth.
Light gray, fine- to medium-grained sand.
Medium- to coarse-grained sand. White to light tan. Trace gravel present.
WELL 28
LITHOLOGY
273
22.5
27.5
70
0
20
26
48
Brown clay, trace silt.
Medium-grained sand.
Light brown to gray clay and silty clay.
Gray clay.


DEPTH, IN FEET BELOW LAND SURFACE
WELL 30
LITHOLOGY
0
10
20
30
40
50
250
33.7
38.7
43
0
8
39
Brown silt and silty clay
Medium- to coarse-grained sand, with abundant gravel layers.
Red-brown clay.
WELL 31
LITHOLOGY
249
34
39
46
0
11
41
Clayey sand, gray.
Sand, gravel layers occur through section.
Clay

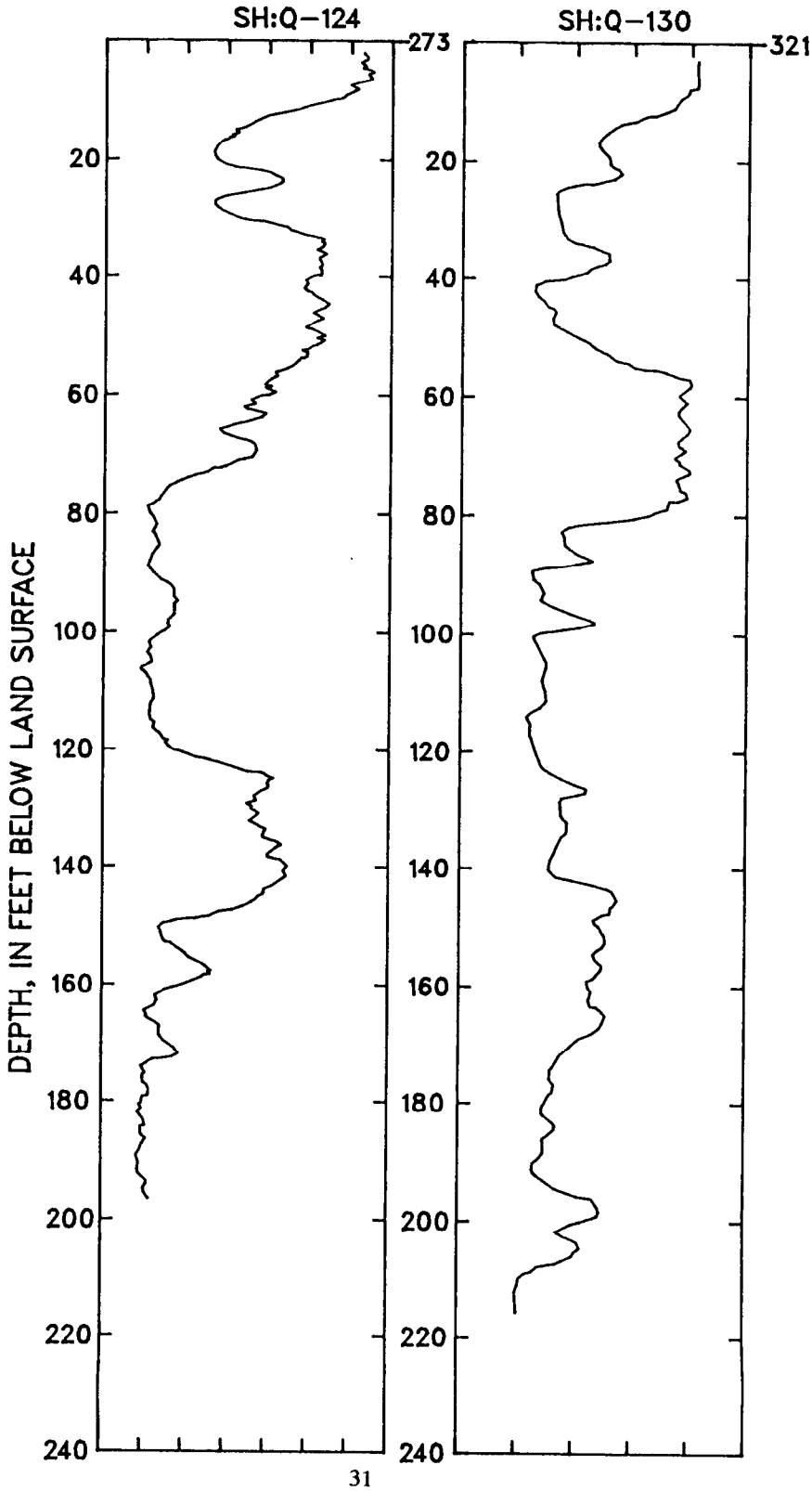

WELL MS-2
WELL C-2
WELL C-1
WELL MS-1
LITHOLOGY
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
250
78.5
83.5
85
103
108
115
146
148
176
178
180
250
0
15
130
150
Silt and silty clay. Some fine sand.
Sand, fine- to coarse-grained, medium gray. Some gravel zones
Sand changing to light green-gray to olive gray in color. Silts and some clay. Trace sand layers.
Interbedded silts, clay, and fine-grained sand.
Clay, dense, gray. Some lignite present.
Sand, fine- to very coarse-grained. Predominantly medium- to coarse-grained. Trace gravel.


WELL MS-3
WELL C-3
WELL MS-4
GAMMA LOG
LITHOLOGY
DEPTH, IN FEET BELOW LAND SURFACE
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
250
53.3
55.3
56
68.7
93.5
97.7
Sand pack
Gravel pack
80
100
140
0
13
39
68
118
121
Silt and some clay.
Sand, medium- to coarse-grained. Some gravel layers.
Clay, silty, red brown to yellow brown.
Clay, gray to medium gray.
Fine-grained sand, silt and trace clay.
Sand, fine- to medium-grained. Some coarse-grained. Sand is predominantly clear quartz.
Clay, light red-brown to pink.
Sand, fine- to medium-grained. Light orange and iron stained.

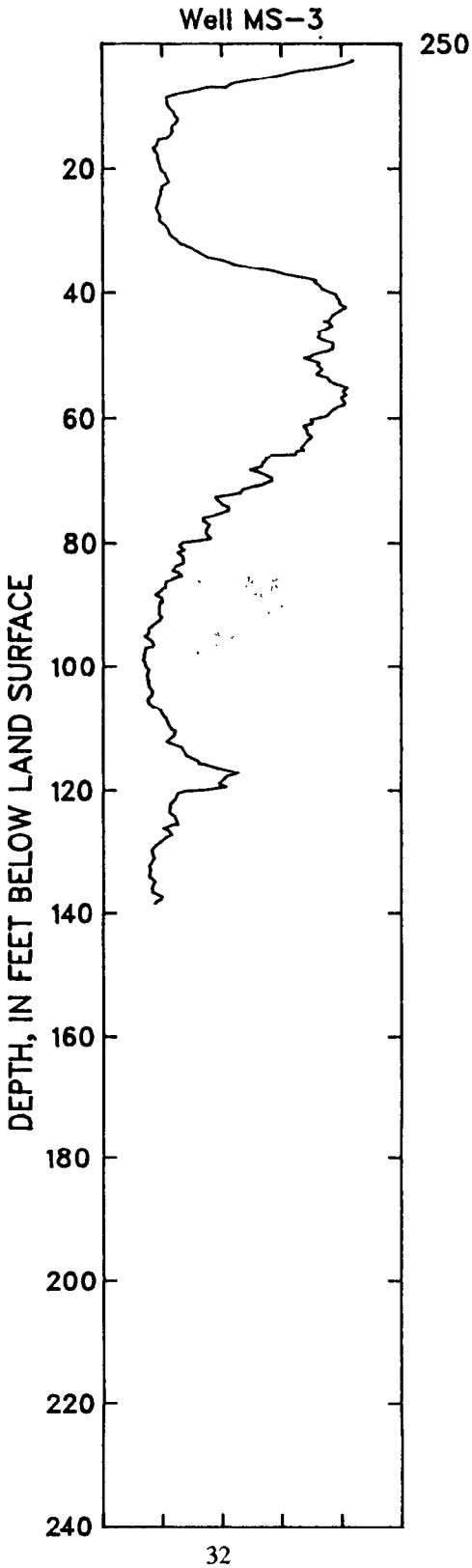
GAMMA LOGS


Well MS–2
Well C–1
Well MS–1
DEPTH, IN FEET BELOW LAND SURFACE
247
20
40
60
80
100
120
140
160
180
200
220
240

STRATIGRAPHIC TEST HOLES
GAMMA LOGS



GAMMA LOG


Well MS-3
250
20
40
60
80
100
120
140
160
180
200
220
240
DEPTH, IN FEET BELOW LAND SURFACE

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
A-413 Federal Building
Nashville, Tennessee 37203